XX. *Letter from Captain* Basil Hall, *R. N. to Captain* Kater, *communicating the details of experiments made by him and Mr.* Henry Foster, *with an Invariable Pendulum; in London; at the Galapagos Islands in the Pacific Ocean, near the Equator; at San Blas de California on the N. W. Coast of Mexico; and at Rio de Janeiro in Brazil. With an Appendix, containing the Second Series of Experiments in London, on the Return.*

Read April 24, 1823.

His Majesty's Ship Conway,
Spithead, 23rd February, 1823.

My Dear Sir,

I herewith transmit the details of the experiments which have been made with the invariable pendulum, placed in my hands by the Board of Longitude, at your suggestion.

It is matter of regret to me, that I should have visited so many remote places, with such means in my hands, and have so few results to produce. The fact however is, that the service upon which I was sent had no connection with scientific research, and that it was only at casual intervals of active professional employment, that I had any leisure for enquiries of this nature. These occasional opportunies I owe to the generous indulgence of Sir Thomas Hardy, the Commander in Chief, to whose assistance, also, and encouragement in every pursuit having useful knowledge for its object, I stand essentially indebted.

In drawing up the following account, care has been taken to state all the attendant circumstances, and to record in the Tables every observation in detail; so that any person wishing to examine the work, may have the best means possible of estimating its value.

The methods followed for making the adjustments of the instruments, conducting the experiments, and deducing the results, were those laid down in your paper on the length of the pendulum at the principal stations of the Trigonometrical Survey. I took care, for example, always to adjust the diaphragm in the focus of the eye-piece of the telescope, so that its edges should coincide exactly with those of the extremity of the pendulum; according to the precept at page 9 of your second paper. (read before the Royal Society in June, 1819.) This adjustment, by the way, is rendered more easy and exact, by placing a card or other white object at a little distance behind the pendulum. I also invariably determined the Intervals by observing the disappearance of the white disk according to your directions at page 11, and the reasoning at page 58 of the first paper,* (read in January, 1818.)

And here I feel it not only due to you, but likely, perhaps, to be of use to future observers, to state that, after many trials of fancied improvements, and simplifications of your methods, both in the conduct of the experiment itself, and in the subsequent computations, I was finally obliged to acknowledge, in every instance, even where I succeeded, that I had by more labour, or by a more circuitous path, reached the same point to which your rules would at once have led me.

* I am particular in stating these two circumstances, especially the first, from its being so essential to the accuracy of the whole experiment, in all cases where the diameter of the disk and the breadth of the pendulum, though in fact equal, are placed at different distances from the eye, and therefore appear under different angles; and not, as in your first paper, where they are so proportioned that both occupy the same apparent space when seen through the telescope. I was at first disposed to think it might be better to observe both the times of disappearance and re-appearance of the white disk, and to assume the mean as the true instant of the coincidence; but I found by repeated trials, that the time of re-appearance was liable to greater or less uncertainty according to the degree of light, and other unmanageable circumstances: and having satisfied myself by demonstration that the method of obtaining the intervals by observing the disappearance was rigorously correct in principle, I adhered to it ever afterwards as being more simple and infallible in practice.

From having carefully studied your works before leaving England, I had conceived myself to be sufficiently qualified to undertake a course of experiments at once. In this, however, I was mistaken; and the consequence has been, that of two extensive series which I made at Valparaiso, neither is I fear sufficiently accurate to deserve your notice. The experience, however, which I gained in the course of these operations, enabled me ever afterwards to proceed with confidence. And here I may take occasion to suggest the advantage which, on future occasions, would arise from having the whole experiment performed in England, by the person who is afterwards to repeat it abroad, not under the hospitable roof of Mr. BROWNE, to whose valuable assistance every one who has attended to this subject, is so deeply obliged, but in the fields, and with no advantages save those which he could carry with him. He would thus in good time discover omissions in his apparatus, which are not to be supplied abroad, and be aided in surmounting difficulties before he had sailed, as I did, beyond the reach of appeal.

The first series of experiments, No. I. was made, as you know, in London. The next, which is marked No. II, was made thirty two miles and a half north of the equator, at one of the Galapagos, a group of islands in the Pacific, lying upwards of two hundred leagues west from the Continent of South America. It was intended that a station should have been chosen immediately under the line, but the ship being swept to leeward in the course of the night by a strong current, this object could not be effected without losing more time than circumstances admitted of being spent in that quarter.

The spot chosen for the experiments lies near the extremity

of a point of land running into the sea at the south end of Abingdon Island, where it forms the western side of a small bay, about a mile across. The point is part of an ancient stream of lava which has flowed down the side of a peaked mountain in the middle of this end of the island. The summit of this peak is between two and three miles from the station, in a direction nearly north, and is about two thousand feet high: it slopes rapidly at first, forming a tolerably steep cone, but terminated by a broad and gently sloping base of a mile and a half. The sides of the mountain are studded with craters, or mouths, from whence at different periods streams of lava have issued, and running down to the sea, have there formed projecting points, such as that on which we fixed our station. The western face of the island presents a cliff nearly perpendicular, and not less than a thousand feet high; it exhibits the rude stratification of lava, tuffa, and ashes, which characterizes the fracture of ancient volcanic mountains. I am thus minute in describing this island, that you may be enabled to judge how far its density may have modified the results of the experiments. It is ten or twelve miles long; the north end being a continued system of long, low, and very rugged streams of lava; the peak standing about one-third of the whole length from the southern extreme, where our station was. The rock at different places not far from the station was found to be full of caves, into which the tide flowed and ebbed through subterranean channels; the outer crust of the stream having, as usual, served as a pipe to conduct the lava off: it is therefore probable that our foundation may not have been the solid rock, a circumstance which, taken along with the general hollow nature of volcanic districts, and the deepness of the surrounding ocean, renders these experiments

not so fit to be compared with those made in England, as with others made on a similar volcanic soil.

The range in the temperature in 24 hours was from 74° to 91°, and as we were obliged to place the instruments in a tent, the temperature rose in the day time, and fell at night, but without any uniformity. On the first day of observing coincidences, a set was taken after breakfast, and another before dinner; but as it was soon seen that this would be to confine the whole of the observations to the hot period of the day, it was determined in future to take one set as soon after sun-rise as possible, in order to have a result which should be influenced by the whole night's continued low temperature; and another set towards the close of the day, in order to have a result partaking in like manner of the influence which the whole day's high temperature might have on the length of the pendulum. I also endeavoured so to arrange things, that I should catch a sufficiently long period of uniform temperature during the interval of each set, that it might be taken with an unvarying thermometer; hoping that by these arrangements, although no one experiment could produce strictly correct results, the opposite errors of the morning and evening observations would counterbalance one another; that is, that the mean, between observations taken both in the hot and in the cold periods of the day, would probably give a just result; or at least such a result as would fairly be entitled to stand by the side of rates deduced from transits of stars, the intervals between taking which, in like manner, included the same extremes of temperature.

It should be borne in mind that the real desideratum, as far as respects rate, is not to know what is the aggregate loss or gain of the clock in twenty-four hours, but the actual rate at

which the clock is going during the particular period of observing; or, in other words, that number of beats, and parts of a beat which, were the clock to go on uniformly from that period, would be indicated by its dial plate, in twenty-four hours, or 86400 seconds of mean time. As the method of transits of stars, however, gives no more than average rates, I sought, by the arrangements above stated, to obtain, in like manner, average results from the mean of observations made at the extreme temperatures.

A thermometer was suspended so that its bulb stood one inch in front of the middle part of the pendulum, and another was hung between the clock case and the pendulum, lower down. The average temperature at night was 74°, and in the day time 86° and 90°; the latter, as I have said, depending principally on the state of the sky. The allowance for expansion was made from the deductions which resulted from your experiments on a similar pendulum; but I propose instituting a series of experiments with the pendulum which I used, in order to investigate this important branch of the subject more directly.

An astronomical circle, by TROUGHTON, was used as a transit instrument, and was so placed in a small octagonal observatory of light pannels communicating by a door with the tent, that the clock could be seen, and its beats heard by the observer at the instrument; thus, with the exception of the first day's transits, the time was recorded directly from the clock, without the intervention of a chronometer. The meridian mark was placed near the sea, at the distance of 806 feet: a strong post having been driven into a cleft of the rock and firmly secured, there was nailed to it a screen made of copper, and perforated with a system of holes from one-fourth to one

tenth of an inch in diameter, and readily distinguishable from the Observatory. The screen being, moreover, made in the form of a box to receive the lamp, it became impossible to misplace the light. The instrument was brought down to this mark, and the level carefully examined before and after every observation, except with some stars which followed too close upon one another. The sun was fortunately observed at noon every day; and as its rays were never allowed to touch any part of the instrument, or to enter the Observatory, except at the moment of noon, and then only through a small hole, I had reason to hope that none of the adjustments were at this observation ever deranged. As the great alternations in temperature alluded to above, might naturally be expected to cause fluctuations in the going of the clock, it was satisfactory to have a series of regularly, and frequently recurring tests, brought to bear upon this essential particular. As the same precautions were observed at every station, this account of them will apply to the whole series of experiments.

But in order to your forming no higher than a correct estimate of this insulated experiment, it is right I should describe to you the peculiar circumstances under which it was performed. It was above all to be regretted that we were so much limited in time, that we could not engage in a fresh series, either at the same island or on some other lying nearer the equator, the service upon which the Conway was employed, rendering it necessary that our stay should not be longer at the Galapagos than the 1 th of January. Now, as we anchored at Abingdon's Island on the 7th at noon, there were barely nine complete days in which every thing was to be done. We had to search for a landing place, which occu-

pied some considerable time; to decide upon a station; our tents to rig up; the Observatory to build; then to land the instruments, and set them up; and as we had no time for trials and alterations, every thing required to be permanently fixed at once. We were fortunate in weather during the first two days, when our things were all lying about, and our habitations ill assorted; but on the third night it rained hard, and the water which trickled through the canvas caused us some discomfort, although we fortunately succeeded in sheltering the instruments. The heat during the day was not only opppressive at the time, but very exhausting in its effects; and at night, although the thermometer never fell lower than 73°, the feeling of cold arising from the transition from 93°, to which it sometimes rose in the day, was no less disagreeable.

It was with reluctance that I left the neighbourhood of the equator, without having made more numerous and more varied, and consequently more unexceptionable observations on the length of the pendulum. It would, above all, have been desirable to have swung it at stations more nearly resembling those with which its vibrations were to be compared. Thus, the results obtained from the experiments at the Galapagos, though curious in themselves, are not so valuable for comparing with those you have deduced in this country. The time may come, however, when they may be rendered more useful; that is to say, should experiments be made with the same pendulum at stations remote from the Galapagos, but resembling them in insular situation, in size, and in geological character; such as the Azores, the Canaries, St. Helena, the Isle of France, and various stations amongst the eastern islands of the Indian and the Pacific oceans. The advantage of having it swung at the Cape of Good Hope,

and especially at the Falkland Islands (which lie in the correspondent latitude to that of London), and at various other stations on the main land, or on large islands, is still more obvious.

At page 240 you will observe the details of the ellipticities deduced; and it is sufficient to mention here, that the length of the second's pendulum at the Galapagos is 39.01717 inches, and the mean of all the ellipticities thereby deduced from your experiments in England, $\frac{1}{284.98}$, and from those of Captain SABINE at Melville Island, $\frac{1}{292.14}$.

SAN BLAS DE CALIFORNIA.*

The tables No. III. contain the details of the experiments made at San Blas, a sea port town on N.W. coast of Mexico, in latitude $21\frac{1}{2}°$ N. and longitude $105\frac{1}{4}°$ W. and not far from the south point of California. These experiments were performed under favourable circumstances, the sky being clear, the temperature steady, and the rate of the clock uniform. The station indeed was more elevated than could have been wished, being 115 feet above the level of the sea, on the summit of a cylindrical rock of compact whin stone, and measuring not more than 500 feet across, and nearly perpendicular in three quarters of its circumference.

The length of the seconds pendulum at San Blas, by these experiments, comes out 39.03776 inches, and the mean ellipticity $\frac{1}{313.55}$.

By a second series of experiments at San Blas, the details of which are given by my coadjutor, Mr. HENRY FOSTER, Mas-

* San Blas is in Mexico, but being near California, it takes that addition to distinguish it from other towns of the same name.

ter's Mate of the Conway, in Experiment No. IV, the length of the seconds pendulum comes out 39.03881, and the mean ellipticity $\frac{1}{308.56}$. The circumstances in this case, however, were not so favourable as those of the first series, being to one another in the ratio of 47 to 397, or nearly as 1 to 8. This arose from the change which took place in the weather at that period, the sky being overcast, the temperature fluctuating, and the rate of the clock unsteady.

RIO DE JANEIRO.

Two extensive series of experiments were made at this place, first by myself, No. V. and then by Mr. FOSTER, No. VI. The total number of the factors in the first case being 210, and in the second 452. The results agree with surprising exactness for operations entirely unconnected. The length of the seconds pendulum by my experiments being - - 39.04381
By Mr. FOSTER - - - - - 30.04368
The mean ellipticity by my experiments is - - $\frac{1}{301.77}$
By Mr. FOSTER - - - - - - $\frac{1}{302.37}$

The circumstances in both cases were favourable, especially in the steadiness of the temperature, and the uniformity of the clock's rate; but as they were decidedly most favourable in the case of Mr. FOSTER's experiments, I have no hesitation in considering his as the most entitled to credit.

Mr. FOSTER is the Gentleman to whose co-operation I owed so much when observing the comet at Valparaiso; an account of which, in a letter to Dr. WOLLASTON, has appeared in a recent Volume of the Transactions. His present work speaks sufficiently for itself; but I should be doing him scanty justice by confining myself to such a reference, without also

stating that, occupied as I was with professional duties, it would have been hopeless to have undertaken these experiments, without the zealous assistance of a person who, besides being free to attend exclusively to the subject, was thoroughly skilled in all its details.

I remain, my dear Sir,

most sincerely yours,

BASIL HALL.

APPENDIX.

Being desirous of presenting an account of these operations to the Royal Society before the vacation, I had not time to repeat the experiments in London before the above letter was read. Since that period, however, I have ascertained, by careful observations, that the number of vibrations made by the pendulum now, does not accord with that which resulted from the experiments made in London before the voyage. By a reference to the additional Tables in the Appendix, page 285* to 288,* and the Remarks which follow, the amount of this discordance will be seen, as well as the explanation of the cause. It is only necessary to mention here that the ellipticities, printed in the above letter, have all been recomputed on the principle stated in the remarks alluded to.

Abstract of the most exact results at each station.

Stations.	Diminution of Gravity from Pole to Equator.	Ellipticity.	Length of Equat. Pend.
Galapagos, $0^{\circ}\ 32'\ ''$ N	,0051412	$\frac{1}{284,98}$	39,017196
San Blas, . 21 30 25 N	,0054611	$\frac{1}{313,55}$	39,00904
Rio, . . 22 55 22 S	,0053431	$\frac{1}{302,37}$	39,01206

B. H.

London, 30*th August,* 1823.

Experiment No. I. at London.

Observation of Coincidences.

3d July, 1820, P.M. at Mr. BROWNE's. Lat. 51° 31′ 8″, 4 }
Height above the sea 83 feet. Clock losing 1s,60 } Bar. 29,92.

Temp. Fahrenheit.	Time of coincidence.	Arc of Vibration.	Mean Arc.	Interval in Seconds.	No. of Vibrations.	Observed Vibrations in 24 hours.	Correction for Arc.	Vibrations in 24 hours.
	h. m. s.							
67°,5	0 4 17	1,19						
			1°,13	1014			2,09	
	21 11	1,07						
			1,00	1015			1,64	
	38 6	0,94						
			0,90	1019			1,33	
	55 5	0,86						
			0,82	1020			1,23	
	1 12 5	0,78						
			0,74	1021			0,90	
68,2	29 6	0,71						
67,8	Mean			1017,8	1015,8	86228,63	1,44	86230,07

4th July, P.M. at Mr. BROWNE's. }
Clock losing - - - 1s,40 } Bar. 30,0.

Temp. Fahrenheit.	Time of coincidence.	Arc of Vibration.	Mean Arc.	Interval in Seconds.	No. of Vibrations.	Observed Vibrations in 24 hours.	Correction for Arc.	Vibrations in 24 hours.
	h. m. s.							
66,9	0 54 41	1,20						
			1,14	1010			2,13	
	1 11 31	1,08						
			1,02	1013			1,71	
	28 24	0,97						
			0,92	1015			1,39	
	45 19	0,88						
			0,84	1018			1,16	
	2 2 17	0,80						
			0,76	1016			0,95	
	19 13	0,73						
			0,69	1020			0,78	
68,1	36 13	0,65						
67,5	Mean			1015,33	1013,33	86228,41	1,35	86229,76

5th July, P. M. at Mr. Browne's.
Clock losing - - - $1^s,20$ } Barom. 30,10.

Temp. Fahrenheit.	Time of coincidence.	Arc of Vibration.	Mean Arc.	Interval in Seconds.	No. of Vibrations.	Observed Vibrations in 24 hours.	Correction for Arc.	Vibrations in 24 hours.
°	h. m. s.							
66,0	0 11 13	1,15						
			° 1,09	1016			1,95	
	28 09	1,04						
			0,99	1018			1,60	
	45 7	0,94						
			0,89	1019			1,30	
	1 2 6	0,85						
			0,81	1019			1,08	
	19 5	0,77						
			0,74	1022			0,94	
	36 7	0,70						
			0,66	1023			0,71	
66,6	53 10	0,63						
66,3	Mean			1019,5	1017,5	86229,31	1,26	86230,57

6th July, P. M. at Mr. Browne's.
Clock losing - - - $1^s,10$ } Barom. 30,13.

Temp. Fahrenheit.	Time of coincidence.	Arc of Vibration.	Mean Arc.	Interval in Seconds.	No. of Vibrations.	Observed Vibrations in 24 hours.	Correction for Arc.	Vibrations in 24 hours.
	h. m. s.							
65,6	1 16 39	1,18						
			1,12	1014			2,06	
	33 33	1,07						
			1,01	1016			1,68	
	50 29	0,96						
			0,91	1017			1,36	
	2 7 26	0,87						
			0,83	1019			1,13	
	24 25	0,79						
			0,76	1018			0,94	
	41 23	0,73						
			0,70	1021			0,80	
66,7	58 24	0,67						
66,1	Mean			1017,5	1015,5	86229,07	1,33	86230,40

7th July, P. M. at Mr. BROWNE'S.
Clock losing - - - $1^s,15$ } Barom. 30,13.

Temp. Fahrenheit.	Time of coincidence.	Arc of Vibration.	Mean Arc.	Interval in Seconds.	No. of Vibrations.	Observed Vibrations in 24 hours.	Correction for Arc.	Vibrations in 24 hours.
	h. m. s.							
65°,8	0 30 43	1,16						
			1°,10	1016			1,98	
	47 39	1,05						
			1,00	1016			1,64	
	1 4 35	0,95						
			0,91	1019			1,36	
	21 33	0,87						
			0,83	1021			1,13	
66,3	38 35	0,79						
66,0	Mean			1018	1016	86229,11	1,53	86230,64

8th July, P. M. at Mr. BROWNE'S.
Clock losing - - - $1^s,00$ } Barom. 30,15.

Temp. Fahrenheit.	Time of coincidence.	Arc of Vibration.	Mean Arc.	Interval in Seconds.	No. of Vibrations.	Observed Vibrations in 24 hours.	Correction for Arc.	Vibrations in 24 hours.
	h. m. s.							
65,7	11 24 49	1,27						
			1,21	1011			2,40	
	41 40	1,15						
			1,09	1013			1,95	
	58 33	1,04						
			0,99	1013			1,60	
	0 15 26	0,94						
			0,90	1017			1,33	
	32 23	0,86						
			0,82	1018			1,10	
	49 22	0,77						
			0,73	1019			0,88	
66,5	1 6 20	0,70						
66,1	Mean			1015,16	1013,16	86228,79	1,54	86230,34

9th July, P. M. at Mr. Browne's.
Clock losing - - - 0,90 } Barom. 30,15.

Temp. Fahrenheit.	Time of coincidence.	Arc of Vibration.	Mean Arc.	Interval in Seconds.	No. of Vibrations.	Observed Vibrations in 24 hours.	Correction for Arc.	Vibrations in 24 hours.
°	h. m. s.	°						
65,1	11 37 4	1,19						
			° 1,13	1017			2,09	
	54 1	1,07						
			1,02	1016			1,71	
	12 10 57	0,98						
			0,94	1019			1,45	
	27 56	0,88						
			0,84	1018			1,15	
	44 54	0,80						
			0,76	1021			0,95	
66,3	1 1 55	0,72						
65,7	Mean			1018,2	1016,2	86229,39	1,49	86230,88

Results.

Date.	Barom.	Therm.	Vibrations in 24 hours.	Correction for Temperature.	Vibrations at 68 degrees.
July 3	29,92	° 67,8	86230,07	— 0,08	86229,99
4	30,00	67,5	86229,76	— 0,21	86229,55
5	30,10	66,3	86230,57	— 0,72	86229,85
6	30,13	66,1	86230,40	— 0,70	86229,70
7	30,13	66,0	86230,64	— 0,85	86229,79
8	30,15	66,1	86230,34	— 0,70	86229,64
9	30,15	65,7	86230,88	— 0,97	86229,91
Mean	30,08	66,5			86229,78
			Correction for Buoyancy		+ 5,98
					86235,76
			Correction for 88 feet		+ 22
No. of vibrations at London in vacuo, at the level of the sea, in temperature 68° . .					= 86235,98

Experiment No. II. at the Galapagos.

Transits observed at the Earl of Abingdon's Island.

Date.	Star.	1st Wire.	2nd. Wire.	Mer. Wire.	4th Wire.	5th Wire.	Mean Chron.	Clock.
January, 1822.		h. m. s.	m. s.	m. s.	m. s.	m. s.		
9	☉'s 1st Limb	12 14 47, 5	15 16, 2	15 44 ,0	16 10, 2	16 38, 0		
	☉'s 2d Limb	0 17 8, 8	17 36, 8	18 4, 5	18 30, 8	18 59, 0		Clock
	☉'s Centre	12 58 58,15	16 26,50	16 54,25	17 20,50	17 48,50	Centre Clock. 12 16 53,62	at mean Noon, 12 9 23,82
							Chro.	Clock.
P. M.	12 Eridani	11 33 32, 2	34 2, 0	34 31, 5	34 59, 5	35 29, 0	11 34 30,95	7 57 29,28
	ι Eridani	. . . .	11 54 6, 5	54 32, 0	54 57, 0	. . .	11 54 31,87	8 17 29,57
	δ Eridani	12 3 48, 5	4 14, 7	4 40, 5	5 5, 2	5 31, 5	12 4 40,15	8 27 37,50
	Rigel	9 57 43, 5	58 9, 0	58 35, 4	59 1, 2	59 29, 5	Obsd. by Clock.	9 58 35,50
	η Orionis	1 44 20, 7	44 46, 7	45 12, 5	45 36, 7	46 1, 7	1 45 11,80	10 8 5,80
	δ Orionis	1 51 43, 0	52 8, 7	52 34, 7	52 58, 7	53 24, 7	1 52 34,08	10 15 27,85
	ι Orionis	1 55 58, 2	56 24, 2	56 50, 0	57 14, 1	57 40, 0	1 56 49,67	10 19 43,37
	ζ Orionis	2 0 33, 0	00 59, 5	1 24, 7	1 49, 5	2 14, 7	2 1 24,35	10 24 17,68
	κ Orionis	2 8 2, 7	8 29, 0	8 55, 2	9 20, 0	9 46, 1	2 8 54,70	10 31 47,70
		After this day the Transits were observed directly with the Clock.						
10	☉'s 1st Limb	12 14 13, 0	14 40, 0	15 6, 8	15 34, 2	16 2, 0		
	☉'s 2d Limb	0 16 32, 8	17 0, 8	17 28, 5	17 55, 0	18 22, 8		Clock
	☉'s Centre	12 15 22,90	15 50 40	16 17,65	16 44,60	17 12,40	Centre 12 16 17,57	at mean Noon. 12 8 23,27
								Mean Clock.
10 P. M.	ζ Eridani	7 54 24, 8	54 50, 8	55 16, 4	55 41, 2	56 7, 0	——	7 55 16,10
	ε Eridani	8 11 42, 0	12 8, 2	12 34, 2	12 58, 5	13 24, 5	——	8 12 33,60
	δ Eridani	8 21 50, 2	22 16, 5	22 43, 5	23 7, 5	23 33, 5	——	8 22 42,45
	β Eridani	9 45 58, 8	46 24, 0	46 49, 0	47 13, 8	47 40, 0	——	9 46 49,10
	Rigel	9 52 48, 5	53 14, 5	53 40, 2	54 5, 0	54 31, 5	——	9 53 39,98
	η Orionis	. . . .	10 2 46, 9	3 11, 5	3 36, 0	4 2, 0	——	10 3 11,25
	δ Orionis	10 9 41, 8	10 8, 0	. . .	10 59, 0	. . .	——	10 10 33,50
	ι Orionis	10 13 56, 8	14 23, 0	14 49, 0	15 13, 0	15 39, 0	——	10 14 48,30
	ζ Orionis	10 18 32, 0	18 57, 5	19 23, 5	19 48, 0	20 13, 8	——	10 19 23,05
11	☉'s 1st Limb	12 13 37, 0	14 5, 2	14 32, 0	14 58, 0	15 25, 0		
	☉'s 2d Limb	0 15 57, 2	16 25, 2	16 52, 8	17 19, 2	17 47, 1		Clock
	☉'s Centre	12 14 47,10	15 15,20	15 42,40	16 8,60	16 36,05	Centre. 12 15 41,96	at mean Noon. 12 7 23,76
11 P. M.	Evening Cloudy.							
12	☉'s 1st Limb	12 13 3, 2	13 32, 0	13 59, 0	14 24, 2	14 52,5		
	☉'s 2d Limb	0 15 23, 5	15 51, 2	16 18, 5	16 45, 0	17 13, 0		
	☉'s Centre	12 14 13,35	14 41,60	15 8,75	15 34,60	16 2,75	12 15 8,30	12 6 26,90
12 P. M.	Evening Cloudy							
13	☉'s 1st Limb	12 12 27, 2	12 55, 2	13 23, 0	13 49, 2	14 17, 0		
	☉'s 2d Limb	0 14 47, 5	15 15, 8	15 43, 8	16 10, 0	16 37, 4		
	☉'s Centre	12 13 37,35	14 5,50	14 33,40	14 59,60	15 27,20	12 14 32,77	12 5 28,67

Transits continued.

Date.	Star.	1st Wire.	2nd Wire.	Mer. Wire.	4th Wire.	5th Wire.	Mean Clock.	Clock at Mean Noon.
Jan. 1822.		h. m. s.	m. s.	m. s.	m. s.	m. s.	h. m. s.	h. m. s.
13 P. M.	α Reticuli	8 43 20, 5	44 18, 0	45 14, 0	46 7, 0	47 3, 8	8 45 12,88	
	β Eridani	9 31 15, 0	31 40, 5	32 6, 0	32 31, 0	32 57, 0	9 32 5,92	
	Rigel	9 38 5, 2	38 31, 0	38 58, 0	39 23, 0	39 49, 0	9 38 57,37	
	η Orionis	9 47 37, 0	48 4, 0	48 29, 0	48 54, 2	49 20, 0	9 48 28,87	
	δ Orionis	9 54 59, 5	55 25, 2	55 51, 0	56 15, 5	56 41, 0	9 55 50,53	
	ε Orionis	9 59 14, 2	59 40, 0	0 6, 0	0 30, 0	0 56, 0	10 0 5,37	
	ζ Orionis	10 3 49, 2	4 15, 2	4 41, 0	5 5, 0	5 31, 0	10 4 40,40	
	⊙'s 1st Limb	12 11 48, 0	12 18, 0	12 45, 5	13 12, 2	13 39, 5		
14	⊙'s 2d Limb	14 10, 0	14 37, 8	15 5, 5	15 31, 2	15 59, 5		
	⊙'s Centre.	12 12 59, 0	13 27,90	13 55,50	14 21,70	14 49,56	12 13 54,85	12 4 28,65
14 P. M.	12 Eridani	7 31 56, 5	32 26, 5	32 56, 0	33 24, 0	33 54, 0	7 32 55,50	
	ζ Eridani	7 34 45, 2	35 12, 0	35 37, 0	36 2, 0	36 28, 5	7 35 36,95	
	ε Eridani	7 52 3, 0	52 29, 0	32 55, 5	53 20, 0	53 47, 0	7 52 55,00	
	δ Eridani	8 2 11, 5	2 38, 0	3 4, 0	3 29, 0	3 55, 0	8 3 3,58	
	α Reticuli	8 38 23, 8	39 21, 5	40 18, 0	41 11, 0	42 8, 5	8 40 16,80	
	β Eridani	. . . .	26 44, 0	27 10, 0	27 34, 0	28 5, 0	9 27 9,50	
	Rigel	9 33 9, 0	33 35, 0	34 1, 8	34 26, 0	34 52, 5	9 34 1,02	
	η Orionis	9 42 40, 5	43 6, 2	43 32, 0	43 56, 2	44 22, 5	9 43 31,57	
	δ Orionis	9 50 2, 5	50 28, 2	50 54, 8	51 18, 2	51 44, 0	9 50 53,75	
	ε Orionis	9 54 17, 2	54 43, 0	55 8, 2	55 33, 0	55 59, 5	9 55 8,18	
	ζ Orionis	9 58 52, 2	. . .	59 43, 2	0 8, 0	0 34, 2	9 59 43,20	
	κ Orionis	10 6 21, 5	6 47, 2	7 13, 5	7 38, 0	8 4, 8	10 7 13,08	
	⊙'s 1st Limb	12 11 10, 0	11 38, 2	12 5, 5	12 31, 5	12 59, 2		
15	⊙'s 2d limb	13 30, 0	13 57, 8	14 25, 2	14 51, 5	15 20, 0		
	⊙'s Centre	12 12 20,00	12 48,00	13 15,35	13 41,50	14 9,60	12 13 14,97	12 3 27,27
15 P. M.	ε Eridani	7 47 6, 8	47 33, 0	47 59, 0	48 24, 0	48 50, 0	7 47 58,63	
	δ Eridani	7 57 15, 0	57 41, 0	58 7, 8	58 32, 0	58 58, 5	7 58 7,02	
	ζ Orionis	. . . .	. . .	, . .	. . .	9 55 37, 5	9 55 37,50	5th Wire.

For the Rates deduced from these Transits, see Tables III. and IV.

Comparisons of Clock with Chronometer.

Date.	Chronometer.	Clock.	Clock Fast.
January 1822.	h. m. s.	h. m. s.	h. m. s.
9 P. M.	11 42 0	20 4 58,0	8 22 58,0
—	0 00 0	8 22 57,5	57,5
—	0 8 0	8 30 57,2	57,2
—	1 43 0	10 5 54,0	54,0
—	2 11 0	10 33 53,0	53,0

A. M. 10th January, 1822, Galapagos.
Clock losing 59^s,36 at a mean rate. } Barom 30,025.

Temp. Fahrenheit.	Time of coincidence.	Arc of Vibration.	Mean Arc.	Interval in Seconds of Clock.	No. of Vibrations.	Observed Vibrations in 24 hours.	Correction for Arc.	Vibrations in 24 hours.
°	h. m. s.	°						
81, 2	9 26 56	1,25						
			° 1,20	683			2,35	
83, 0	38 19	1,16						
			1,13	682			2,09	
83, 8	49 41	1,09						
			1,05	684			1,80	
84, 1	10 01 5	1,01						
			0,97	683			1,54	
85, 2	12 28	0,93						
			0,89	685			1,29	
85, 8	23 53	0,86						
			0,83	683			1,12	
87, 8	35 16	0,80						
			0,78	683			0,99	
87, 1	46 39	0,75						
			0,72	683			0,85	
87, 8	58 2	0,70						
85,09	10 4 Mean Solar Time			683,25	681,25	86087,91	1,50	86089,41

P. M. 10th January. Barom. 29,90.

Temp. Fahrenheit.	Time of coincidence.	Arc of Vibration.	Mean Arc.	Interval in Seconds of Clock.	No. of Vibrations.	Observed Vibrations in 24 hours.	Correction for Arc.	Vibrations in 24 hours.
	h. m. s.							
91, 2	1 53 23	1,30						
			1,25	674			2,55	
90, 1	2 4 37	1,21						
			1,17	676			2,24	
89, 8	15 53	1,13						
			1,09	676			1,94	
90, 2	27 09	1,05						
			1,02	676			1,70	
91, 3	38 25	0,98						
			0,95	677			1,48	
90, 1	49 42	0,92						
			0,89	677			1,29	
88, 0	3 0 59	0,86						
			0,83	679			1,12	
87, 2	12 18	0,80						
			0,77	677			0,97	
87, 0	23 35	0,75						
89,43	2 30 Mean Solar Time.			676, 5	674,5	86085,38	1,66	86087,04

A. M. 11th January. Barom. 29,965.

Temp. Fahrenheit.	Time of coincidence.	Arc of Vibration.	Mean Arc.	Interval in Seconds of Clock.	No. of Vibrations.	Observed Vibrations in 24 hours.	Correction for Arc.	Vibrations in 24 hours.
°	h. m. s.	°						
73,3	6 44 12	1,23						
			° 1,17	690			2,24	
74,2	55 42	1,12						
			1,08	689			1,91	
75,0	7 7 11	1,03						
			0,99	689			1,60	
75,5	18 40	0,95						
			0,91	689			1,35	
—	30 9	0,88						
			0,84	688			1,15	
77,0	41 37	0,80						
			0,77	687			0,97	
78,0	53 4	0,73						
			0,69	688			0,78	
78,5	8 4 32	0,65						
			0,61	686			0,61	
79,5	15 58	0,56						
76,37	7 23 Mean Solar Time			688,25	686,25	86089,75	1,33	86091,08

P. M. 11th January. Barom. 29,90.

Temp. Fahrenheit.	Time of coincidence.	Arc of Vibration.	Mean Arc.	Interval in Seconds of Clock.	No. of Vibrations.	Observed Vibrations in 24 hours.	Correction for Arc.	Vibrations in 24 hours.
	h. m. s.							
84,5	5 1 51	1,32						
			1,27	680			2,64	
—	13 11	1,22						
			1,18	680			2,28	
83,5	24 31	1,14						
			1,10	678			1,98	
83,0	35 49	1,07						
			1,04	680			1,77	
82,5	47 9	1,00						
			0,96	680			1,51	
82,0	58 29	0,93						
			0,90	681			1,32	
81,8	6 9 50	0,87						
			0,84	682			1,15	
81,0	21 12	0,81						
82,61	5 30 Mean Solar Time			680,14	678,14	86086,75	1,81	86088,56

A. M. 12th January, 1822, Galapagos. } Barom. 29,93.
Clock losing 59^s,36 at a mean rate. }

Temp. Fahrenheit.	Time of coincidence.	Arc of Vibration.	Mean Arc.	Interval in Seconds of Clock.	No. of Vibrations.	Observed Vibrations in 24 hours.	Correction for Arc.	Vibrations in 24 hours.
°	h. m. s.	°						
74,5	6 20 43	1,30	°					
			1,25	679			2,25	
74,2	32 02	1,20						
			1,15	678			2,16	
74,2	43 20	1,14						
			1,07	678			1,87	
74,2	54 38	1,04						
			1,01	682			1,67	
74,5	7 6.00	0,97						
			0,93	682			1,41	
74,7	17 22	0,90						
			0,87	684			1,24	
75,0	28 46	0,84						
			0,81	682			1,07	
76,2	40 8	0,78						
			0,75	682			0,92	
77,5	51 30	0,72						
75,0	7 0 Mean Solar Time			680,875	678,87	86087,03	1,61	86088,64

P. M. 12th January. Barom. 29,90.

Temp. Fahrenheit.	Time of coincidence.	Arc of Vibration.	Mean Arc.	Interval in Seconds of Clock.	No. of Vibrations.	Observed Vibrations in 24 hours.	Correction for Arc.	Vibrations in 24 hours.
°	h. m. s.							
84, 0	4 20 51	1,30						
			1,25	678			2,55	
83, 5	32 9	1,20						
			1,15	680			2,16	
83, 1	43 29	1,11						
			1,08	680			1,91	
82, 8	54 49	1,04						
			1,01	682			1,67	
82, 3	5 6 11	0,97						
			0,94	683			1,44	
82, 0	17 34	0,91						
			0,88	685			1,27	
81, 3	28 59	0,86						
			0,83	684			1,12	
81, 0	40 23	0,80						
			0,77	684			0,97	
80, 5	51 47	0,75						
82,28	5 0 Mean Solar Time			682,0	680,0	86087,44	1,64	86089,08

A. M. 13th January. Barom. 29,955.

Temp. Fahrenheit.	Time of coincidence.	Arc of Vibration.	Mean Arc.	Interval in Seconds of Clock.	No. of Vibrations.	Observed Vibrations in 24 hours.	Correction for Arc.	Vibrations in 24 hours.
°	h. m. s.	°						
74, 2	6 59 32	1,28	°					
			1,23	685			2,47	
74, 2	7 10 57	1,18						
			1,13	685			2,09	
74, 2	22 22	1,09						
			1,05	686			1,80	
74, 5	33 48	1,01						
			0,98	686			1,57	
74, 8	45 14	0,94						
			0,91	686			1,35	
75, 0	56 40	0,88						
			0,85	686			1,18	
75, 2	8 8 6	0,82						
			0,80	688			1,05	
76, 0	19 24	0,77						
			0,75	688			0,92	
76, 6	31 2	0,71						
74,97	7 40 Mean Solar Time			686,25	684,25	86089,01	1,55	86090,56

P. M. 13th January. Barom. 29,91.

Temp. Fahrenheit.	Time of coincidence.	Arc of Vibration.	Mean Arc.	Interval in Seconds of Clock.	No. of Vibrations.	Observed Vibrations in 24 hours.	Correction for Arc.	Vibrations in 24 hours.
80, 1	5 7 27	1,20						
			1,15	684			2,16	
79, 8	18 51	1,10						
			1,06	685			1,84	
79, 4	30 16	1,02						
			0,99	686			1,60	
79, 0	41 42	0,96						
			0,93	686			1,41	
78, 8	53 8	0,90						
			0,87	686			1,24	
78, 3	6 4 34	0,84						
			0,82	687			1,10	
78, 1	16 1	0,79						
79,07	5 37 Mean Solar Time			685,67	683,67	86088,79	1,56	86090,35

A. M. 14th January, 1823, Galapagos. Clock losing $59^s,36$ at a mean rate. } Barom. 29,94.

Temp. Fahrenheit.	Time of coincidence.	Arc of Vibration.	Mean Arc.	Interval in Seconds of Clock.	No. of Vibrations.	Observed Vibrations in 24 hours.	Correction for Arc.	Vibrations in 24 hours.
°	h. m. s.	°						
76, 5	7 17 30	1,25						
			° 1,20	690			2,35	
77, 2	29 00	1,16						
			1,13	692			2,09	
77, 6	41 32	1,09						
			1,06	691			1,84	
78, 5	52 3	1,02						
			0,98	690			1,57	
79, 2	8 3 33	0,94						
			0,91	692			1,35	
80, 2	15 5	0,88						
			0,85	693			1,18	
81, 2	26 38	0,81						
			0,79	691			1,02	
83, 0	38 9	0,76						
			0,74	691			0,89	
84, 6	49 40	0,71						
79,77	8 4 Mean Solar Time			691,25	689,25	86090,83	1,54	86092,37

P. M. 14th January. Barom. 29,89.

Temp. Fahrenheit.	Time of coincidence.	Arc of Vibration.	Mean Arc.	Interval in Seconds of Clock.	No. of Vibrations.	Observed Vibrations in 24 hours.	Correction for Arc.	Vibrations in 24 hours.
	h. m. s.							
86, 6	4 4 50	1,31						
			1,26	685			2,60	
86, 5	16 15	1,21						
			1,16	686			2,20	
85, 2	27 41	1,12						
			1,08	688			1,91	
84, 7	39 9	1,03						
			0,99	690			1,60	
83, 5	50 39	0,96						
			0,93	690			1,41	
83, 2	5 2 9	0,90						
			0,88	692			1,27	
83, 3	13 41	0,85						
			0,82	691			1,10	
83, 2	25 12	0,79						
			0,76	691			0,94	
83, 0	36 43	0,73						
84,36	4 47 Mean Solar Time			689,125	687,13	86090,06	1,63	86091,69

A. M. 15th January. Barom. 29,94.

Temp. Fahrenheit.	Time of coincidence.	Arc of Vibration.	Mean Arc.	Interval in Seconds of Clock.	No. of Vibrations.	Observed Vibrations in 24 hours.	Correction for Arc.	Vibrations in 24 hours.
°	h. m. s.	°	°					
75, 3	6 36 9	1,28	1,24	690			2,51	
76, 0	47 39	1,19	1,14	689			2,12	
76, 8	59 08	1,10	1,06	692			1,84	
77, 0	7 10 40	1,02	0,98	693			1,57	
77, 1	22 13	0,95	0,92	694			1,38	
77, 3	33 47	0,89	0,85	692			1,18	
78, 2	45 19	0,82	0,79	691			1,02	
80, 0	56 50	0,77	0,74	690			0,89	
81, 0	8 8 20	0,71						
77,63	7 19 Mean Solar Time			691,375	689,38	86090,88	1,56	86092,44

P. M. 15th January. Barom. 29,895.

Temp. Fahrenheit.	Time of coincidence.	Arc of Vibration.	Mean Arc.	Interval in Seconds of Clock.	No. of Vibrations.	Observed Vibrations in 24 hours.	Correction for Arc.	Vibrations in 24 hours.
°	h. m. s.							
86, 8	4 3 15	1,30	1,25	681			2,55	
86, 3	14 36	1,20	1,15	682			2,16	
85, 2	25 58	1,10	1,06	684			1,84	
84, 3	37 22	1,01	0,98	685			1,57	
83, 8	48 47	0,95	0,92	687			1,38	
83, 2	5 00 14	0,89	0,85	687			1,18	
82, 6	11 41	0,82	0,80	689			1,05	
82, 0	23 10	0,77	0,74	689			0,89	
81, 7	34 39	0,72						
83,99	4 46 Mean Solar Time			685,5	683,5	86088,74	1,58	86090,32

TABLE I.

Time by the Clock of Transits of Stars at the Galapagos.

Stars.	January 9.	January 10.	January 13.	January 14.	January 15.
1822.	h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.
12 Eridani	7 57 29,28	——	——	7 32 55,50	——
ζ Eridani	——	7 55 16,10	——	7 35 36,95	——
ε Eridani	8 17 29,57	8 12 33,60	——	7 52 55,00	7 47 58,63
δ Eridani	8 27 37,50	8 22 42,45	——	8 3 3,58	7 58 7,02
α Reticuli	——	——	8 45 12,88	8 40 16,80	——
β Eridani	——	9 46 49,10	9 32 5,92	9 27 9,50	——
Rigel	9 58 35,50	9 53 39,98	9 38 57,37	9 34 1,02	——
γ Orionis	10 8 5,80	10 3 11,25	9 48 28,87	9 43 31,57	——
δ Orionis	10 15 27,85	10 10 33,50	9 55 50,53	9 50 53,75	——
ε Orionis	10 19 43,37	10 14 48,30	10 00 5,37	9 55 8,18	——
					(5th Wire)
ζ Orionis	10 24 17,68	10 19 23,05	10 4 40,40	9 59 43,20	9 55 37,50
Do. (5th wire)	25 8,03	20 13,80	5 31,00	0 34,20	——
κ Orionis	10 31 47,70	——	——	10 7 13,08	——

TABLE II.

Transits of the Sun.

Time by Clock at the moment of mean Noon.

January 9.	January 10.	January 11.	January 12.	January 13.	January 14.	January 15.
h. m. s.	m. s.	m. s.	m. s.	m. s.	m. s.	m. s.
12 9 23,82	8 23,27	7 23,27	6 26,90	5 28,67	4 28,65	3 27,27

From these two Tables (which are formed from the last column of the Transit Table, pages 226 and 227,) the following Rates have been computed, by comparing the transits of each night with those of each of the other nights, when the same stars were observed, dividing the difference by the number of days in the interval, and subtracting from the quotient $3^m\ 55^s,91$, the acceleration in one day; to this rate $0^s,16$ have been added for the additional loss of the clock in four minutes, to obtain the rate in a mean solar day.

The sun was fortunately observed every day throughout the whole of these operations; so that by comparing the time by clock at the moment of mean noon of each day, with that on each succeeding day, the rate for 21 separate intervals is obtained.

TABLE III.

Rate of the Clock by the Stars. Losing.

1822. Stars.	Jan. 9, to Jan. 10.	9 to 13	9 to 14	9 to 15	10 to 13	10 to 14	10 to 15	13 to 14	13 to 15	14 to 15
	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.
12 Eridani	—	—	59,01	—	—	—	—	—	—	—
ζ Eridani	—	—	—	—	—	59,04	—	—	—	—
ε Eridani	60,22	—	59,16	59,41	—	58,90	59,24	—	—	60,62
δ Eridani	59,30	—	59,03	59,33	—	58,97	59,34	—	—	60,81
α Reticuli	—	—	—	—	—	—	—	60,33	—	—
β Eridani	—	—	—	—	58,64	59,15	—	60,67	—	—
Rigel	59,77	58,78	59,14	—	58,45	58,99	—	60,60	—	—
η Orionis	58,80	58,48	59,10	—	58,37	59,17	—	61,55	—	—
δ Orionis	58,60	58,58	59,07	—	58,57	59,19	—	61,03	—	—
ε Orionis	59,32	58,75	59,29	—	58,56	59,28	—	61,44	—	—
ζ Orionis	58,88	58,57	59,14	—	58,47	59,20	—	61,45	—	—
Do. (5th wire)	—	—	—	59,34	—	—	59,51	—	61,00	60,95
κ Orionis	—	—	59,17	—	—	—	—	—	—	—
Mean by Stars.	59,27	58,63	59,12	59,36	58,51	59,10	59,36	61,01	61 0	60,79
Times to which the above are due (mean solar time.)	10th $9^h\ 30^m$ A. M.	11th $9^h\ 56^m$ P. M.	12th $9^h\ 17^m$ A. M.	12th $8^h\ 42^m$ P. M.	12th $9^h\ 51^m$ A. M.	12th $9^h\ 11^m$ P. M.	13th $8^h\ 41^m$ A. M.	14th $9^h\ 34^m$ A. M.	14th $9^h\ 56^m$ P. M.	15th $8^h\ 33^m$ A. M.

Note. $0^s,16$ have been added to each of the rates by the stars, being the loss in $3^m\ 56^s$ to obtain the rate for a mean solar day.

TABLE IV. *Rate by the Sun. Losing.*

	9th to 10th	9th to 11th	9th to 12th	9th to 13th	9th to 14th	9th to 15th	10th to 11th	10th to 12th	10th to 13th	10th to 14th	10th to 15th
	$60^s,55$	$60^s,03$	$58^s,97$	$58^s,79$	$59^s,03$	$59^s,43$	$59^s,51$	$58^s,18$	$58^s,20$	$58^s,65$	$59^s,20$
Times to which the above rates are due.	8 min. A. Noon 10th	8 min. A. Mid^t. 10th	8 min. A. Noon 11th	8 min. A. Mid^t. 11th	9 min. A. Noon 12th	8 min. A. Mid^t 10th	8 min. A. Noon 11th	8 min. A. Mid^t 11th	9 min. A. Noon 12th	9 min. A. Mid^t. 12th	9 min. A. Mid^t. 11th

	11th to 12th	11th to 13th	11th to 14th	11th to 15th	12th to 13th	12th to 14th	12th to 15th	13th to 14th	13th to 15th	14th to 15th
	$56^s,86$	$57^s,55$	$58^s,37$	$59^s,12$	$58^s,23$	$59^s,13$	$59^s,88$	$60^s,02$	$60^s,70$	$61^s,38$
Times to which the above rates are due.	9 min. A. Noon 12th	9 min. A. Mid^t. 12th	9 min. A. Noon 13th	9 min. A. Mid^t. 12th	9 min. A. Noon 13th	9 min. A. Mid^t. 13th	9 min. A. Mid^t. 13th	10 min. A. Noon. 14th	10 min. A. Mid^t. 14th	

The rates in the foregoing Tables are due to the middle moment of the intervals between the respective transits from whence they were inferred. The mean rates, in the case of the stars, are due to the middle moment between the mean of the times of the transits on the one night, and the mean of the times of the transits on the other. In the case of the sun, the rates are due to the middle moment between the respective apparent noons. In both cases these middle moments are given (in mean solar time), in order to facilitate an inspection of the three following Tables.

TABLE V.

Vibrations of the Pendulum at the Galapagos,

computed at the mean rate of the clock, viz. 86340,64 Vibrations in a mean Solar Day.

Date.	A. M. or P. M.	Middle time of each set of Coincidences.	Barom.	Therm.	Vibrations in 24 hours.	Correction for Temp.	Vibrations in 24 hours. at 68°
		(Mean Solar Time) h. m.	Inches.	°			
January 10	A. M.	10 4	30,02	85,1	86089,41	7,23	86096,64
	P. M.	2 30	29,90	89,4	86087,04	9,05	86096,09
— 11	A. M.	7 23	29,96	76,4	86091,08	3,55	86094,63
	P. M.	5 30	29,90	82,6	86088,56	6,18	86094,74
— 12	A. M.	7 00	29,93	75,0	86088,64	2,96	86091,60
	P. M.	5 00	29,90	82,3	86089,08	6,06	86095,14
— 13	A. M.	7 40	29,96	75,0	86090,56	2,96	86093,52
	P. M.	5 37	29,91	79,1	86090,35	4,69	86095,04
— 14	A. M.	8 4	29,94	79,8	86092,37	4,99	86097,36
	P. M.	4 47	29,89	84,4	86091,69	6,94	86098,63
— 15	A. M.	7 19	29,94	77,6	86092,44	4,06	86096,50
	P. M.	4 46	29,89	84,0	86090,32	6,77	86097,09
		Mean	29,93	80,9			86095,58

The numbers in the above Table have been deduced from the rate of the clock between the 9th and 15th, viz. 59,36, losing. The corrections for temperature are at the rate of $+0^s,423$ for each degree of Fahrenheit above 68°.

TABLE VI.

By the Stars.

From	To	Mean of the Times in the intervals.		Computed Vibrations in a mean solar day.	Mean of Transit before or after Coincidence.	Final Correction for unequal rate.	Corrected Vibrations in a mean solar day.	No. of Stars observed.	Interval of Transits.	
		Day.	h. m.		before					
10 A. M.	10 P. M.	10	0 17	86096,46	$2^h\ 47^m$	+,04	86096,50	7	1	7
10 A. M.	13 P. M.	11	12 20	86095,40	2 24	,00	86095,40	5	4	20
10 A. M.	14 P. M.	12	0 21	86095,58	3 4	—,10	86095,48	9	5	45
10 A. M.	15 P. M.	12	12 18	86095,58	3 36	—,11	86095,47	3	6	18
11 A. M.	13 P. M.	12	0 22	86094,96	2 31	—,08	86094,88	6	3	18
11 A. M.	14 P. M.	12	12 23	86095,34	3 12	—,10	86095,24	9	4	36
11 A. M.	15 P. M.	13	0 19	86095,42	3 38	—,11	86095,31	3	5	15
14 A. M.	14 P. M.	14	0 25	86096,35	2 51	—,09	86096,26	7	1	7
14 A. M.	15 P. M.	14	12 14	86095,75	2 18	—,07	86095,68	1	2	2
15 A. M.	15 P. M.	15	0 2	86095,35	3 29	+,07	86095,42	3	1	3
		(Mean Solar Time.			Mean by the Stars		86095,56	Sum of Factors		171

TABLE VII.

By the Sun.

From	To	Mean of the times in the intervals.		Computed Vibrations in a mean solar day.	Mean of Transit before or after coincidences.	Final Correction for unequal rate.	Corrected Vibrations in a mean solar day.	No. of Stars observed.	Interval of Transits.	
		day.	h. m.							
10 A. M.	10 P. M.	10	0 17	86095,69	B. 0 9	+,01	86095,70	2	2	4
10 A. M.	11 P. M.	10	12 22	86095,91	B. 0 14	+,01	86095,92	2	3	6
10 A. M.	12 P. M.	11	0 15	86095,38	B. 0 7	+,01	86095,39	2	4	8
10 A. M.	13 P. M.	11	12 20	86095,00	B. 0 12	rate uniform	86095,00	2	5	10
10 A. M	14 P. M.	12	0 21	86095,27	B. 0 12	—,01	86095,26	2	6	12
10 P. M.	11 A. M.	10	10 56	86095,22	A. 1 12	+,06	86095,28	2	1	2
10 P. M.	12 A. M.	10	23 36	86095,44	A. 0 32	+,03	86095,47	2	2	4
10 P. M.	13 A. M.	11	11 50	86095,45	A. 0 18	+,01	86095,46	2	3	6
10 P. M.	14 A. M.	12	0 5	86095,47	A. 0 4	Insensible	86095,47	2	4	8
10 P. M.	15 A. M.	12	12 5	86095,48	A. 0 4	—	86095,48	2	5	10
11 P. M.	12 A. M.	11	12 15	86095,67	B. 0 6	—,01	86095,66	2	1	2
11 P. M.	13 A. M.	12	0 18	86095,57	B. 0 9	—,01	86095,56	2	2	4
11 P. M.	14 A. M.	12	12 28	86095,56	B. 0 19	—,02	86095,54	2	3	6
11 P. M.	15 A. M.	13	0 22	86095,56	B. 0 13	—,01	86095,55	2	4	8
12 P. M.	13 A. M.	12	12 20	86095,46	B. 0 11	—,01	86095,45	2	1	2
12 P. M.	14 A. M.	13	0 35	86095,50	B. 0 26	—,02	86095,48	2	2	4
12 P. M.	15 A. M.	13	12 25	86095,51	B. 0 16	—,01	86095,50	2	3	6
13 P. M.	14 A. M.	13	12 50	86095,54	B. 0 41	—,03	86095,51	2	1	2
13 P. M	15 A. M.	14	0 27	86095,54	B. 0 17	—,01	86095,53	2	2	4
14 P. M.	15 A. M.	14	12 3	86095,54	A. 0 7	+,01	86095,55	2	1	2
					Mean by the Sun		86095,49	Sum of Factors.		110

These two last Tables have been calculated according to the method explained at pages 13 and 14 of Captain KATER's second Paper on the Pendulum (1819). It consists in taking the mean of all the vibrations, and all the corresponding (middle) times of the coincidences, embraced by a certain interval, from Table V.; and then comparing the mean rate ($59^s,36$) with the rate actually ascertained by transits, which embrace the same, or rather a greater interval, but whose middle time corresponds nearly with the mean time of the said vibrations drawn from Table V. The difference between the mean rate and the observed rate is then applied to the mean of the vibrations; and it is only when the mean time of the transits and that of the coincidences do not agree that the final correction is necessary, and also supposing the rate of the clock not uniform.

Observation for the Latitude of the Station, viz. S. W. Point of the Earl of Abingdon's Island, Galapagos.

January 16, 1822. Barom. 29,97 Thermom. 90°.
Sun on the Meridian by the clock, at $12^h\ 12^m\ 34^s,7$.

Face of Instrument.	Times by Clock.	Time from Noon.	Nat. Vers[d] Sines.	Altitude and Zenith distance of Sun's Upper and Lower Limbs.	Sun's Semi-diameter.	Altitudes of Sun's centre.
	h. m. s.	m. s.		° ′ ″	′ ″	° ′ ″
East	12 2 48,5	9 46,2	908	68 7 30 L	+ 16 17,2	68 23 47,2
	3 56	8 38,7	712	9 8,5 L	+ ——	25 25,7
	5 5,5	7 29,2	533	10 27,5 L	+ ——	26 44,7
	7 2	5 32,7	293	12 46 L	+ ——	29 3,2
	8 20,5	4 14,2	171	13 55 L	+ ——	30 12,2
	9 38	2 56,7	83	14 36 L	+ ——	30 53,2
	12 27	0 7,7	0	15 22,5 L	+ ——	31 39,7
West	16 2	3 27,3	113	21 46 32,5 L	— ——	29 44,7
	18 55,5	6 20,8	384	48 51,5 L	— ——	27 25,7
	20 10	7 35,3	547	50 26 L	— ——	25 51,2
	21 52	9 17,3	820	52 50 L	— ——	23 27,2
	23 20	10 45,3	1100	22 20 U	+ ——	21 22,8
	24 48,5	12 13,8	1424	25 22,5 U	+ ——	18 20,3
	26 23	13 48,3	1812	28 44 U	+ ——	14 58,8
			807,18			

	° ′ ″		
Latitude	0 32 20	Cos.	9,9999808
Declination	20 56 41	Cos.	9,9703123
Altitude	68 30 59	Sect.	10,4362401
Log. Sine	1	A. C.	5,3144251
Log of	807″,18 (+ 4)		6,9069704
Log Cor. +	424″,55		2,6279287
Correction +	7′ 4″,55		

		° ′ ″
Altitude of ☉'s centre	.	68 24 12,85
Refraction	.	— 0 21,12
Parallax	.	+ 0 3,33
Correction	.	+ 7 4,55
Change of Declination	.	+ 0 0,34
☉'s true meridian zenith distance	.	21 29 0,05
Declination	.	20 56 41, 0S.
Latitude of the Station		0 32 19,05N.

Thus we have obtained 86095,56 vibrations of the pendulum deduced from the stars, and 86095,49 by the sun, in twenty-four hours, mean solar time. These results, however, as Captain KATER has shown in his paper of 1819, are entitled to credit in the ratio of the sum of the factors arising from multiplying the number of stars observed by the days in the

interval between the observation. For the stars we have 171, and for the sun 110; so that the final number of vibrations may be taken as 86095,54.

The ball of the pendulum was twelve feet above the level of low water, the correction for which, by the duplicate ratio of the distances from the earth's centre, is nearly $0^v,05$ in twenty-four hours. As the station was the tabular surface of an old stream of lava, not very compact, I suppose the proper multiplier is $\frac{66}{100}$, which will give $0^v,03$ for the correction due to this elevation.

The mean height of the barometer was 29,93, and the mean temperature 80°,9, whence it appears that the specific gravity of the pendulum was to that of air, as 7458 to 1, which gives $5^v,77$ as a correction to be added to the number of vibrations to arrive at the number it would have made in vacuo; and adding also 0,03 for the elevation, we have 86101,34 for the number of vibrations made by the pendulum, at the level of the sea in vacuo at 68° of FAHRENHEIT, in a mean solar day, at the Galapagos, in latitude 0° 32′ 19″ north, and longitude 90°½ west.

The same pendulum in London made 86235,98 vibrations in the same interval, and reduced to the level of the sea. Whence the length of the seconds pendulum at the Galapagos, deduced from the duplicate ratio of these vibrations, and assuming the length of the seconds pendulum in London 39,13929, appears to be 39,0171692, or 39,01717 inches of Sir G. SHUCKBURGH'S scale.

By comparing the lengths of the seconds pendulum at the principal stations in the British survey as ascertained by Captain KATER'S experiments, the diminution of gravity from the pole to the equator, and the resulting ellipticity, are as follows:

Extreme Stations.	Diminution of Gravity from Pole to Equator.	Ellipticity	Length of Equatorlal Pendulum.
Unst in . . 60° 45′ 28″ and Galapagos in 0° 32′ 19″	,0051945	$\frac{1}{289,35}$	39.01715
Portsoy in . . 57 40 59	,0051833	$\frac{1}{288,41}$	.01715
Leith Fort in 55 58 41	,0051632	$\frac{1}{286,76}$	.01718
Clifton 53 27 43	,0051038	$\frac{1}{281,93}$	.01715
Arbury Hill . 52 12 56	,0051316	$\frac{1}{284,18}$	.01744
London . . 51 31 9	,0051083	$\frac{1}{282,31}$	.01715
Shanklin Farm 50 37 24	,0051038	$\frac{1}{281,92}$	.01715
Mean . .	,0051412	$\frac{1}{284,98}$	39.017196

Experiment No. III. at San Blas, in Mexico.

First Series. By Captain Hall.

Comparison of Chronometer 438 with clock at San Blas. (1st series.)

Date.	Chronometer.	Clock.	Difference.
1822,	h. m. s.	h. m. s.	h. m. s.
Noon, May 14th,	4 16 45,5	11 25 0	7 8 14,50
P. M.	11 45 50,0	6 54 0	10,00
	0 26 50,5	7 35 0	9,50
	0 47 51,0	7 56 0	9,00
	1 28 51,2	8 37 0	8,80
	1 57 51,5	9 6 0	8,50
	2 23 51,7	9 32 0	8,30
Noon, 15th,	4 9 58,5	11 18 0	7 8 1,50
P. M.	11 27 2,5	6 35 0	7 57,50
	11 42 2,8	6 50 0	57,20
	0 23 3,0	7 31 0	57,00
	0 48 3,4	7 56 0	56,60
	1 27 3,7	8 35 0	56,30
	1 56 3,9	9 4 0	56,10
	2 22 4,1	9 30 0	55,90
Noon, 16th May,	4 8 10, 0	11 16 0	7 7 50,00
P. M.	11 36 15, 0	6 44 0	45,00
	0 22 15, 5	7 30 0	44,50
	0 44 15, 7	7 52 0	44,30
	1 20 16, 0	8 28 0	44,00
	1 55 16, 2	9 3 0	43,80
	2 14 16, 5	9 22 0	43,50
Noon, 17th,	4 6 24, 5	11 14 0	7 7 35,50
P. M.	11 32 31, 8	6 40 0	28,20
	0 13 32, 3	7 21 0	27,70
	0 37 32, 5	7 45 0	27,50
	1 17 33, 0	8 25 0	27,00
	1 47 33, 5	8 55 0	26,50
	2 10 33, 7	9 18 0	26,30
Noon, 18th,	4 8 41, 8	11 16 0	7 7 18,20
P. M.	11 28 47, 4	6 36 0	12,60
	0 9 47, 8	7 17 0	12,20
	0 31 48, 0	7 39 0	12,00
	1 11 48, 5	8 19 0	11,50
	1 42 48, 8	8 50 0	11,20
	2 5 49, 0	9 13 0	11,00
Noon, 19th,	4 6 57, 0	11 14 0	7 7 3,00
P. M.	11 24 1, 0	6 31 0	6 59,00
	0 5 1, 3	7 12 0	58,70
	0 27 1, 5	7 34 0	58,50
	1 9 2, 0	8 16 0	58,00
	1 46 2, 3	8 53 0	57,70
	2 1 2,50	9 8 0	57,50
Noon, 20th,	4 6 9, 7	11 13 0	7 6 50,30

Transits observed at San Blas. (1*st series.*)

Date.	Stars.	1st Wire.	2nd Wire.	Mer. Wire.	4th Wire.	5th Wire.	Mean Chron.	Mean Clock.
1822.		h. m. s.	m. s.	m. s.	m. s.	m. s.		h. m. s.
May 14	☉'s 1st Limb	4 0 56,25	1 23,25	1 50,75	2 16,25	2 44, 0		
	☉'s 2d Limb	4 3 10,75	3 38,25	4 5,25	4 31,00	4 58, 0		
	☉'s Centre	4 2 3,50	2 30,75	2 58,00	3 23,75	3 51, 0	Mean Centre 4 2 57,48	11 11 12,11
							Clock at mean Noon	11 15 10,17
P. M.	β Ursæ Maj.	11 27 17, 5	28 5, 5	28 52, 5	29 38,25	30 26, 0	11 28 52,04	6 37 2,21
	ψ ———	11 36 13,75	36 50, 5	37 27, 0	38 2, 0	38 38, 0	11 37 26,37	6 45 36,45
	δ Leonis	11 41 31, 5	41 59, 5	42 27, 0	42 53,25	43 20, 5	11 42 26,46	6 50 36,46
	γ Ursæ Maj.	12 20 38, 5	21 22, 5	22 7, 5	22 49, 0	23 33, 5	12 22 6,42	7 30 15,97
	δ ———	12 42 34, 5	43 23, 5	44 12,25	44 58, 0	45 47, 0	12 44 11,25	7 52 20,28
	Cor Caroli	1 24 6, 0	24 39, 5	25 12,25	25 43,75	26 17, 0	1 25 11,79	8 33 20,62
	ζ Ursæ Maj.	1 52 38, 5	53 24, 0	54 10, 0	54 53, 5	55 39, 5	1 54 9,25	9 2 17,78
	g ———	1 53 58, 0	54 44, 5	55 29, 5	56 13, 5	56 59,25	1 55 29,04	9 3 37,54
	η ———	2 16 32, 0	17 12,25	17 52,75	18 30, 5	19 11, 0	2 17 51,87	9 26 00,22
15	☉'s 1st Limb	4 0 34, 0	1 3, 5	1 30, 0	1 56, 0	2 23, 5		
	☉'s 2d Limb	4 2 49, 5	3 16, 5	3 43, 5	4 9, 5	4 36, 5		
	☉'s Centre	4 1 41,75	2 10, 0	2 36,75	3 2,75	3 30, 0	Mean Centre 4 2 36,33	11 10 37,90
							Clock at mean Noon	11 14 36,00
P. M.	β Ursæ Maj.	11 23 0, 0	23 48, 0	24 35, 5	25 20, 5	26 8, 5	11 24 34,67	6 32 32,20
	ψ ———	11 31 55,25	32 32, 5	33 9, 5	33 44, 0	34 21, 0	11 33 8,62	6 41 6,05
	δ Leonis	11 37 15, 5	37 42,25	38 10, 0	38 36, 0	39 3, 5	11 38 9,54	6 46 6,89
	γ Ursæ Maj.	12 16 21,25	17 5, 5	17 50, 5	18 32, 0	19 16,75	12 17 49,42	7 25 46,48
	δ ———	12 38 17, 5	39 6,25	39 55,25	40 41, 0	41 29, 5	11 39 54,12	7 47 50,80
	Cor Caroli	1 19 49, 0	20 22, 0	20 55, 5	21 27, 0	22 0, 5	1 20 54,92	8 28 51,28
	ζ Ursæ Maj.	1 48 20,75	49 7, 0	49 52, 5	50 36, 0	51 22, 0	1 49 51,79	8 57 47,95
	g ———	1 49 40, 5	50 27, 0	51 12, 5	51 56, 0	52 42, 0	1 51 11,75	8 59 7,90
	η ———	2 12 15,25	12 56, 0	13 36, 0	14 13,25	14 53, 5	2 13 35,00	9 21 31,00
16	☉'s 1st Limb	4 0 14, 0	0 41,00	1 8,75	1 34,25	2 1,75		
	☉'s 2d Limb	4 2 29, 0	2 56,25	3 23,50	3 49,00	4 16,50		
	☉'s Centre	4 1 21,50	1 48,63	2 16,13	2 41,63	3 9,13	Mean Centre 4 2 15,56	11 10 5,62
							Clock at mean Noon	11 14 3,12
P. M.	β Ursæ Maj.	11 18 43, 5	19 31,75	20 19, 5	21 4, 0	21 52, 0	11 20 18,37	6 28 3,52
	ψ ———	11 27 41, 5	28 16, 5	28 52, 5	29 27, 5	30 4, 0	11 28 52,42	6 36 37,49
	δ Leonis	11 33 0, 0	33 26, 5	33 54, 0	34 20, 5	34 48, 0	11 33 53,83	6 41 38,86
	γ Ursæ Maj.	12 12 3, 5	12 49, 5	13 32, 5	14 14, 5	14 59, 5	12 13 32,00	7 21 16,58
	δ ———	12 33 59,75	34 49, 0	35 37,75	36 21, 0	37 10,25	12 35 35,92	7 43 20,31
	Cor Caroli	1 15 32, 0	16 4,75	16 38, 5	17 9, 5	17 43, 0	1 16 37,71	8 24 21,74
	ζ Ursæ Maj.	1 44 4, 5	44 49, 0	45 35, 0	46 22, 5	47 5, 0	1 45 35,23	8 53 19,13
	g ———	1 45 23,25	46 8, 0	46 55, 5	47 44, 0	48 25,25	1 46 55,25	8 54 39,15
	η ———	2 7 58, 0	8 38, 5	9 18,75	9 56, 5	10 36,75	2 9 17,87	9 17 1,42

Date.	Stars.	1st Wire.	2nd Wire.	Mer. Wire.	4th Wire.	5th Wire.	Mean Chron.	Mean Clock.
1822.		h. m. s.	m. s.	m. s.	m. s.	m. s.	h. m. s.	h. m. s.
	⊙'s 1st Limb	3 59 57, 0	0 3,25	0 50,75	1 17, 0	1 44,25		
May 17	⊙'s 2d Limb	4 2 11, 5	2 38, 5	3 6, 0	3 32, 0	3 58,75		
	⊙'s Centre	4 1 4,25	1 31,00	1 58,37	2 24,50	2 51,50	Mean Centre 4 1 58,00	11 9 33,54
							Clock at mean Noon	11 13 29,84
P. M.	β Ursæ Maj.	11 14 29, 0	15 17, 0	16 4, 5	16 49, 5	17 37, 5	11 16 3,67	6 23 32,03
	ψ ——	11 23 24, 5	24 1,75	24 38, 0	25 13, 0	25 50, 0	11 24 37,54	6 32 5,82
	δ Leonis	11 28 44, 0	29 11,25	29 38,75	30 5, 0	30 32, 5	11 29 38,37	6 37 6,40
	γ Ursæ Maj.	12 7 49,75	8 34, 5	9 19, 0	10 1, 0	10 46, 5	12 9 18,29	7 16 46,02
	δ ——	12 29 46, 5	30 35, 0	31 23,75	32 9, 5	32 58,25	12 31 22,79	7 38 50,36
	Cor Caroli	1 11 17,75	11 51, 0	12 24, 0	12 56, 5	13 29, 0	1 12 23,71	8 19 50,77
	ζ Ursæ Maj.	1 39 50,25	40 36, 0	41 22,25	42 5,75	42 51, 5	1 41 21,33	8 48 47,90
	g ——	1 41 10,25	41 56, 0	42 42, 0	43 25, 0	44 11, 0	1 42 41,04	8 50 7,61
	η ——	2 3 44,00	4 24,25	5 4,25	5 42,25	6 22, 5	2 5 3,58	9 12 29,94
	⊙'s 1st Limb	3 59 40, 0	0 6,25	0 34, 0	0 59, 5	1 27, 0		
18	⊙'s 2d Limb	4 1 53,75	2 20,50	2 48,25	3 14, 0	3 42, 0		
	⊙'s Centre	4 0 46,87	1 13,37	1 41,12	2 6,75	2 34,50	Mean Centre 4 1 40,62	11 8 58,89
							Clock at mean Noon	11 12 53,49
P. M.	β Ursæ Maj.	11 10 15,00	11 2,75	11 50, 5	12 35,25	13 23,25	11 11 49,54	6 19 2,31
	ψ ——	11 19 10,75	19 48, 5	20 24, 5	20 59,25	21 36, 0	11 20 23,91	6 27 36,59
	δ Leonis	11 24 29,75	24 57, 5	25 25, 0	25 50,75	26 18, 0	11 25 24,33	6 32 36,97
	γ Ursæ Maj.	12 3 35,25	4 20,25	5 4, 5	5 46,75	6 31, 5	12 5 3,79	7 12 16,03
	δ ——	12 25 32, 0	26 20, 5	27 9, 5	27 55,25	28 44, 0	12 27 8,46	7 34 20,51
	Cor Caroli	1 7 3,75	7 36,25	8 9, 0	8 40, 5	9 14, 5	1 8 8,83	8 15 20,37
	ζ Ursæ Maj.	1 35 35,50	36 21, 5	37 7,25	37 51, 0	38 36,25	1 37 6,46	8 44 17,72
	g ——	1 36 55,00	37 41, 0	38 27, 5	39 10,75	39 56,75	1 38 26,41	8 45 37,67
	η ——	1 59 29,75	0 9, 5	0 49,75	1 27, 5	2 7,25	2 0 48,92	9 7 59,98
	⊙'s 1st Limb	3 59 23, 0	59 49, 5	0 16,25	0 42, 0	1 9,50		
19	⊙'s 2d Limb	4 1 36, 5	2 3, 5	2 31,25	2 57, 5	3 25,00		
	⊙'s Centre	4 0 29,75	0 56,50	1 23,75	1 49,75	2 17,25	Mean Centre 4 1 23,44	11 8 26,49
							Clock at mean Noon	11 12 18,69
P. M.	β Ursæ Maj.	11 5 57,75	6 45,75	7 33,25	8 17,75	9 6,00	11 7 32,29	6 14 31,43
	ψ ——	11 14 53,75	15 30, 5	16 7, 0	16 41,50	17 18, 5	11 16 6,37	6 23 5,45
	δ Leonis	11 20 13,00	20 40, 0	21 8,25	21 33, 5	22 1,25	11 21 7,57	6 28 6,40
	γ Ursæ Maj.	11 59 18,25	0 2,75	0 47,50	1 29, 0	2 14,25	0 0 46,54	7 7 45,29
	δ ——	12 21 15, 0	22 4, 0	22 52,25	23 38, 0	24 26, 5	0 22 51,33	7 29 49,88
	Cor Caroli	1 2 46, 0	3 19, 0	3 52, 5	4 24, 0	4 57,25	1 3 51,87	8 10 49,93
	η Ursæ Maj.	1 55 11, 5	55 52, 0	56 31, 5	57 10, 0	57 50,50	1 56 31,17	9 3 28,72
	⊙'s 1st Limb	3 59 2,50	59 29, 0	59 57, 5	0 23, 0	0 50,75		
20	⊙'s 2d Limb	4 1 17,75	1 44, 5	2 12, 0	2 37,75	3 5,00		
	⊙'s Centre	4 0 10,12	1 36,75	1 4,75	1 30,37	1 57,07	Mean Centre 4 1 4,10	11 7 54,40
							Clock at mean Noon	11 11 43,80

Observations of Coincidences at San Blas. (1st series.)

May 14, P.M. Clock losing at a mean rate 34s,33. Barom. 29,76.								
Temp. Fahrenheit.	Time of coincidence.	Arc of Vibration.	Mean Arc.	Interval in Seconds.	No. of Vibrations.	Observed Vibrations in 24 hours.	Correction for Arc.	Vibrations in 24 hours.
°	h. m. s.	°						
85,0	3 33 42	1,33	°					
85,0	3 44 56	1,23	1,28	674			2,68	
85,0	56 11	1,13	1,18	675			2,28	
85,0	4 7 27	1,04	1,08	676			1,91	
84,9	18 45	0,96	1,00	678			1,63	
84,7	30 2	0,89	0,93	677			1,44	
84,5	41 21	0,82	0,86	679			1,18	
84,5	52 40	0,77	0,79	679			1,02	
84,6	5 3 59	0,71	0,74	679			0,89	
84,8				677,12	675,12	86110,57	1,63	86112,20
May 15th. A. M. Barom. 29,80.								
79,6	5 13 29	1,30						
,7	24 47	1,20	1,25	678			2,55	
,8	36 7	1,11	1,15	680			2,16	
,9	47 25	1,03	1,07	678			1,81	
80,1	58 44	0,96	0,99	679			1,60	
,3	6 10 6	0,89	0,93	682			1,41	
,5	21 27	0,82	0,85	681			1,21	
,7	32 48	0,76	0,79	681			1,02	
,8	44 9	0,71	0,73	681			0,89	
80,2				680,0	678,0	86111,65	1,58	86113,23
P. M. 15th May. Barom. 29,74.								
85,5	3 30 7	1,31						
,3	41 21	1,21	1,26	674			2,59	
,1	52 36	1,12	1,16	675			2,20	
,1	4 3 53	1,04	1,08	677			1,91	
,2	15 10	0,97	1,01	677			1,63	
,1	26 27	0,90	0,93	677			1,44	
,0	37 45	0,84	0,87	678			1,24	
84,8	49 4	0,79	0,81	679			1,10	
,6	5 0 23	0,74	0,76	679			0,94	
85,1				677,0	675,0	86110,53	1,63	86112,16

Temp. Fahrenheit.	Time of coincidence.	Arc of Vibration.	Mean Arc.	Interval in Seconds.	No. of Vibrations.	Observed Vibrations in 24 hours.	Correction for Arc.	Vibrations in 24 hours.
May 16th. A. M.						**Barom. 29,80.**		
o	h. m. s.	o						
77,5	5 7 47	1,30	o					
,8	19 7	1,19	1,24	680			2,51	
78,1	30 27	1,10	1,14	680			2,16	
,2	41 46	1,02	1,06	679			1,84	
,0	53 7	0,95	0,97	681			1,54	
,2	6 4 28	0,88	0,91	681			1,38	
,3	15 49	0,82	0,85	681			1,18	
,5	27 11	0,77	0,79	682			1,05	
,6	38 33	0,72	0,74	682			0,89	
78,0				680,75	678,75	86111,93	1,57	86113,50
May 16th. P. M.						**Barom. 29,75.**		
83,5	2 57 27	1,34						
,6	3 8 43	1,23	1,28	676			2,68	
,8	19 58	1,14	1,18	675			2,31	
,9	31 13	1,05	1,09	675			1,94	
,9	42 30	0,98	1,01	677			1,70	
,9	53 48	0,91	0,94	678			1,44	
,9	4 5 6	0,84	0,87	678			1,27	
,9	16 24	0,78	0,81	678			1,07	
,9	27 43	0,73	0,75	679			0,92	
83,8				677	675	86110,53	1,67	86112,20
May 17th. A. M.						**Barom. 29,82.**		
77,5	5 6 29	1,31						
,5	17 47	1,21	1,26	678			2,60	
,6	29 5	1,12	1,16	678			2,22	
,7	40 23	1,04	1,08	678			1,91	
,8	51 43	0,96	1,00	680			1,63	
,9	6 3 3	0,89	0,92	680			1,38	
78,1	14 22	0,83	0,86	679			1,21	
,5	25 43	0,78	0,80	681			1,07	
,5	37 3	0,72	0,75	680			0,92	
77,9				679,25	677,25	86111,37	1,62	86112,99

May 17, P.M. Clock losing 34^s,33 at a mean rate. Barom. 29,86.								
Temp. Fahrenheit.	Time of coincidence.	Arc of Vibration.	Mean Arc.	Interval in Seconds.	No. of Vibrations.	Observed Vibrations in 24 hours.	Correction for Arc.	Vibrations in 24 hours.
°	h. m. s.	°						
84,8	2 57 26	1,34	°					
,8	3 8 44	1,23	1,28	678			2,68	
,8	20 4	1,13	1,18	680			2,28	
,8	31 23	1,04	1,08	679			1,91	
,7	42 44	0,96	1,00	681			1,63	
,8	54 4	0,89	0,92	680			1,38	
,7	4 5 26	0,83	0,86	682			1,21	
,5	16 48	0,78	0,80	682			1,07	
,3	28 12	0,73	0,75	684			0,92	
84,7				680,75	678,75	86111,93	1,63	86113,56
May 18th. A. M. Barom. 29,86.								
77,1	5 24 20	1,29						
,1	35 43	1,19	1,24	683			2,51	
,2	47 5	1,10	1,14	682			2,12	
,2	58 28	1,02	1,06	683			1,84	
,6	6 9 53	0,94	0,98	685			1,57	
78,1	21 17	0,88	0,91	684			1,35	
,8	32 43	0,82	0,85	686			1,18	
79,1	44 8	0,76	0,79	685			1,02	
,2	55 33	0,71	0,73	685			0,89	
77,9				684,2	682,2	86113,21	1,56	86114,77
May 18th. P.M. Barom. 29,83.								
85,1	2 50 25	1,29						
85,0	3 1 39	1,19	1,24	674			2,51	
84,9	12 55	1,10	1,14	676			2,12	
85,0	24 13	1,02	1,06	678			1,84	
85,0	35 32	0,95	0,98	679			1,60	
85,1	46 51	0,88	0,91	679			1,38	
84,9	58 10	0,82	0,85	679			1,18	
84,9	4 9 30	0,77	0,79	680			1,02	
85,0	20 51	0,72	0,74	681			0,92	
85,0				678,25	676,25	86110,99	1,57	86112,56

Temp. Fahrenheit.	Time of coincidence.	Arc of Vibration.	Mean Arc.	Interval in Seconds.	No. of Vibrations.	Observed Vibrations in 24 hours.	Correction for Arc.	Vibrations in 24 hours.
May 19th. A. M.						**Barom. 29,83.**		
°	h. m. s.	°						
78,2	4 58 23	1,32	°					
,1	5 9 45	1,22	1,25	682			2,55	
,0	21 7	1,13	1,17	682			2,24	
,0	32 31	1,05	1,09	684			1,94	
,1	43 54	0,97	1,01	683			1,66	
,3	55 18	0,89	0,93	684			1,41	
,6	6 6 43	0,83	0,86	685			1,21	
,8	18 9	0,77	0,80	686			1,05	
,9	29 34	0,72	0,74	685			0,89	
78,3				683,88	681,88	86113,09	1,62	86114,71
May 19th. P. M.						**Barom. 29,78.**		
84,5	3 58 25	1,34						
,2	4 9 43	1,23	1,28	678			2,68	
,2	21 3	1,14	1,18	680			2,31	
,2	32 24	1,05	1,09	681			1,94	
,2	43 46	0,98	1,01	682			1,70	
,0	55 8	0,92	0,95	682			1,47	
83,9	5 6 31	0,86	0,89	683			1,29	
,9	17 54	0,81	0,83	683			1,15	
,8	29 17	0,76	0,78	683			0,99	
84,1				681,5	679,5	86112,21	1,69	86113,90
May 20th. A. M.						**Barom. 29,80.**		
78,4	5 30 3	1,33						
78,0	41 25	1,23	1,28	682			2,68	
78,3	52 50	1,14	1,18	685			2,28	
78,8	6 4 15	1,05	1,09	685			1,98	
79,0	15 40	0,98	1,01	685			1,70	
79,5	27 4	0,92	0,95	684			1,47	
80,0	38 30	0,86	0,89	686			1,29	
80,1	49 56	0,80	0,83	686			1,12	
80,3	7 1 22	0,75	0,77	686			0,97	
79,1				684,88	682,88	86113,46	1,69	86115,15

TABLE I. (1st. Series.)

Times by the Clock of Transits of Stars at San Blas de California.

Stars.	May 14th.	May 15th.	May 16th.	May 17th.	May 18th.	May 19th.
	h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.
β Ursæ Maj.	6 37 2,21	6 32 32,20	6 28 3,52	6 23 32,03	6 19 2,31	6 14 31,43
ψ ———	6 45 36,45	6 41 6,05	6 36 37,49	6 32 5,82	6 27 36,59	6 23 5,45
δ Leonis	6 50 36,46	6 46 6,89	6 41 38,86	6 37 6,40	6 32 36,97	6 28 6,40
γ Ursæ Maj.	7 30 15,97	7 25 46,48	7 21 16,58	7 16 46,02	7 12 16,03	7 7 45,29
δ ———	7 52 20,28	7 47 50,80	7 43 20,31	7 38 50,36	7 34 20,51	7 29 49,88
Cor. Caroli	8 33 20,62	8 28 51,28	8 24 21,74	8 19 50,77	8 15 20,37	8 10 49,93
ζ Ursæ Maj.	9 2 17,78	8 57 47,95	8 53 19,13	8 48 47,90	8 44 17,72	
g ———	9 3 37,54	8 59 7,90	8 54 39,15	8 50 7,61	8 45 37,67	
η ———	9 26 00,22	9 21 31,00	9 17 1,42	9 12 29,94	9 7 59,98	9 3 28,72

TABLE II.

Transits of the Sun.

Time by Clock at the moment of mean Noon.

May 14th.	15th.	16th.	17th.	18th.	19th.	20th.
h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.
11 15 10,17	11 14 36,00	11 14 3,12	11 13 29,84	11 12 53,49	11 12 18,69	11 11 43,80

TABLE III.

Rate of the Clock by the Stars Transits. (Losing.)

Stars.	From 14th to 15th May.	14 to 16	14 to 17	14 to 18	14 to 19	15 to 16	15 to 17	15 to 18	15 to 19	16 to 17	16 to 18	16 to 19	17 to 18	17 to 19	18 to 19
	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.
β Ursæ Maj.	34,10	33,43	34,15	34,06	34,25	32,77	34,17	34,05	34,28	35,58	34,69	34,79	33,81	34,39	34,97
ψ ———	34,49	33,57	34,30	34,05	34,29	32,65	34,20	33,91	34,24	35,76	34,54	34,77	33,32	34,27	35,23
δ Leonis	33,66	32,89	34,11	33,96	34,10	32,12	34,33	34,06	34,21	36,55	35,03	34,91	33,52	34,09	34,66
γ Ursæ Maj.	33,58	33,78	34,07	34,07	34,23	33,99	34,32	34,24	34,39	34,65	34,36	34,52	34,08	34,45	34,83
δ ———	33,57	34,07	34,06	34,03	34,17	34,58	34,31	34,19	34,32	34,04	33,99	34,23	33,94	34,33	34,72
Cor. Caroli	33,43	33,53	34,04	34,15	34,23	33,63	34,34	34,39	34,43	35,06	34,77	34,69	34,49	34,51	34,53
ζ Ursæ Maj.	33,92	33,41	34,05	34,10	—	32,91	34,11	34,17	—	35,32	34,79	—	34,27	—	—
g ———	33,73	33,28	34,07	34,06	—	32,84	34,23	34,17	—	35,63	34,83	—	34,03	—	—
η ———	33,31	33,49	34,18	34,15	34,39	33,67	34,62	34,43	34,66	35,57	34,81	34,99	34,05	34,70	35,35
Mean Proportion for rate in $3^m, 56^s$	33,75 + ,09	33,49 + ,09	34,11 + ,09	34,07 + ,09	34,24 + ,09	33,24 + ,09	34,29 + ,09	34,18 + ,09	34,36 + ,09	35,35 + ,09	34,65 + ,09	34,70 + ,09	33,95 + ,09	34,39 + ,09	34,90 + ,09
Rate in a mean solar day.	33,84	33,58	34,20	34,16	34,33	33,33	34 38	34,27	34,45	35,44	34,74	34,79	34,04	34,48	34,99
Times to which the above rates are due.	$8^h 41^m$ A. M. 15	$8^h 39^m$ P.M.15	$8^h 37^m$ A.M.16	$8^h 35^m$ P.M.16	$8^h 24^m$ A.M.17	$8^h 37^m$ A.M.16	$8^h 35^m$ P.M.16	$8^h 33^m$ A.M.17	$8^h 22^m$ P.M.17	$8^h 33^m$ A.M.17	$8^h 31^m$ P.M.17	$8^h 20^m$ A.M.18	$8^h 29^m$ A.M.18	$8^h 18^m$ P.M.18	$8^h 16^m$ A.M.19

TABLE IV.

Rates by Sun's Transit. Clock losing. (1*st Series.*)

14 to 15	14 to 16	14 to 17	14 to 18	14 to 19	14 to 20	15 to 16	15 to 17	15 to 18	15 to 19
s. 34,17	s. 33,52	s. 33,44	s. 34,17	s. 34,30	s. 34,39	s. 32,88	s. 33,08	s. 34,17	s. 34,35
$11^h 56^m$ P.M. 14	$11^h 56^m$ A.M. 15	$11^h 56^m$ P.M. 15	$11^h 56^m$ A.M. 16	$11^h 56^m$ P.M. 16	$11^h 56^m$ A.M. 17	$11^h 56^m$ P.M. 15	$11^h 56^m$ A.M. 15	$11^h 56^m$ P.M. 16	$11^h 56^m$ A.M. 17

15 to 20	16 to 17	16 to 18	16 to 19	16 to 20	17 to 18	17 to 19	17 to 20	18 to 19	18 to 20	19 to 20
s. 34,44	s. 33,28	s. 34,81	. 34,81	s. 34,83	s. 36,35	s. 35,57	s. 35,35	s. 34,80	s. 34,84	s. 34,89
$11^h 56^m$ P.M. 17	$11^h 56^m$ P.M. 16	$11^h 56^m$ A.M. 17	$11^h 56^m$ P.M. 17	$11^h 56^m$ A.M. 18	$11^h 56^m$ P.M. 17	$11^h 56^m$ A.M. 18	$11^h 56^m$ P.M. 18	$11^h 56^m$ P.M. 18	$11^h 56^m$ A.M. 19	11,56 P.M. 19

TABLE V. (1*st Series*).

Vibrations of the Pendulum at San Blas,

The Clock making 86365,67 Vibrations in a Mean Solar Day.

Date.		Barom.	Thermom.	Difference of Temperature from 68 degrees.	Vibrations in 24 hours.	Corrections for Temperature.	Vibrations in 24 hours, in Temperature 68 degrees.
		Inches.	°	°			
May 14	P. M.	29,76	84,8	16,8	86112,20	+ 7,11	86119,31
15	A. M.	29,80	80,2	12,2	86113,23	+ 5,16	86118,39
	P. M.	29,74	85,1	17,1	86112,16	+ 7,23	86119,39
16	A. M.	29,80	78,0	10,0	86113,50	+ 4,23	86117,73
	P. M.	29,75	83,8	15,8	86112,20	+ 6,68	86118,88
17	A. M.	29,82	77,9	9,9	86112,99	+ 4,19	86117,18
	P. M.	29,86	84,7	16,7	86113,56	+ 7,06	86120,62
18	A. M.	29,86	77,9	9,9	86114,77	+ 4,19	86118,96
	P M.	29,83	85,0	17,0	86112,56	+ 7,19	86119,75
19	A. M.	29,83	78,3	10,3	86114,71	+ 4,36	86119,07
	P. M.	29,78	84,1	16,1	86113,90	+ 6,81	86120,71
20	A. M.	29,80	79,1	11,1	86115,15	+ 4,69	86119,84
Mean		29,80	81,6				86119,15

TABLE VI. 1*st Series.*

By the Stars.				
	Correct Vibrations in a Mean Solar Day.	Number of Stars observed.	Interval of Transits.	Sum of the Factors.
From 15 A. M. to 15 P. M.	86119,38	9	1	9
16	86119,35	9	2	18
17	86118,83	9	3	27
18	86119,03	9	4	36
19	86119,07	7	5	35
16 A. M. to 16 P. M.	86119,30	9	1	9
17	86118,55	9	2	18
18	86118,91	9	3	27
19	86118,99	7	4	28
17 A. M. to 17 P. M.	86117,79	9	1	9
18	86118,72	9	2	18
19	86118,92	7	3	21
18 A. M. to 18 P. M.	86119,64	9	1	9
19	86119,47	7	2	14
19 A. M. to 19 P. M.	86119,23	7	1	7
Mean by Stars -	86119,01	Sum of Factors		285

TABLE VII.

By the Sun.				
	Correct Vibrations in a Mean Solar Day.	Number of Stars observed.	Interval of Transits.	Sum of the Factors.
From 14 P. M. to 15 A. M.	86119,01	2	1	2
16	86119,51	2	2	4
17	86119,37	2	3	6
18	86118,97	2	4	8
19	86118,96	2	5	10
20	86119,09	2	6	12
15 P. M. to 16 A. M.	86120,01	2	1	2
17	86119,54	2	2	4
18	86118,95	2	3	6
19	86118,95	2	4	8
20	86119,10	2	5	10
16 P. M. to 17 A. M.	86119,08	2	1	2
18	86118,43	2	2	4
19	86118,60	2	3	6
20	86118,88	2	4	8
17 P. M. to 18 A. M.	86117,77	2	1	2
19	86118,36	2	2	4
20	86118,80	2	3	6
18 P. M. to 19 A. M.	86118,94	2	1	2
20	86119,33	2	2	4
19 P. M. to 20 A. M.	86119,71	2	1	2
Mean by Sun -	86119,02	Sum of Factors		112

Observations for the Latitude.

San Blas, 20th May, 1822. Barometer 29,78. Thermometer 83°. Chronometer too fast for mean time $4^h\ 4^m\ 45^s$. Polaris on the meridian below the Pole by the Chronometer at $1^h\ 8^m\ 41^s$. True apparent N. P. D. 1° 38′ 28″,46.

Face of Instrument.	Chronometer.	Time from the Meridian.	Nat. Versed Sines.	Observed Zenith Distance and Altitudes.	Altitude.
	h. m. s.	m. s.		° ′ ″	° ′ ″
East	1 6 5	2 36	64	70 3 34,5	19 56 25, 5
	1 7 51	0 50	7	5 34	56 26
	1 8 41	0 0	0	3 35	56 25
West	1 14 3	5 22	274	19 56 19	56 19
	1 16 11	7 30	535	56 18	56 18
	1 18 35	9 54	933	56 20,5	56 20, 5
			302,17		19 56 22,33 Obs. altitude,
					2 27,48 Refraction.
					1,77 Correction.
					0,01 $2'r$ C
					19 53 53,07 True altitude.
					+1 38 28,46 Apparent P.D.
					21 32 21,53 Latitude.

	° ′ ″		
Latitude -	21 32 22	Cosine	9,9685600
Declination	88 21 31	Cosine	8,4570295
Altitude -	19 53 53	Secant	10,0267337
Constant Log. when Stars are obs.			5,3168000
		Constant Log.	3,7691232
Log of	302,17 (+4)	-	6,4802470
Correction	— 1″,77	Log.	0,2493702

June 4th, 1822. *Face of Circle, West.*

Barometer 29,75. Thermometer 86°. Sun's declination 22° 26′ 42″,4.

		° ′ ″
Readings	1st Vernier .	80 50 0
	2nd Vernier .	50 10
Obs. merid. alt. ☉'s L. L.		88 50 5
☉'s semi-diameter .	+	15 47,14
Refraction . .	—	0,10
True merid. alt. ☉'s centre		89 5 52,04
☉'s merid zenith dist.		0 54 7,96
Declination . .		22 26 42,40
Latitude, face west . .		21 32 34,44

June 6th, 1822. *Face of Circle, East.*

Barometer 29,80. Thermometer 85°. Sun's declination 22° 39′ 57″,9.

		° ′ ″
Readings	1st Vernier .	1 23 30
	2nd Vernier .	23 25
Obs. zenith dist. ☉'s L. L.		1 23 27, 5
☉'s semi-diameter .		15 47, 0
Refraction . .	+	1, 0
Parallax . .	—	0,78
☉'s true mer. zenith dist.		1 7 40,72
Declination . . .		22 39 57, 9
Latitude, Face East .		21 32 17,18

Latitude, Face West . .	21 32 34,44 N.
East . .	21 32 17,18
Latitude by the Sun . .	21 32 25,81
Polaris . .	21 32 21,53
Latitude of Observatory .	21 32 23,67 N.

Thus we have obtained 86119,01 vibrations by the rates deduced from the transits of stars, and 86119,02 by the sun's transits. But the sums of the factors being respectively 285 and 112, the former determination, or 86119,01, may be taken for the final mean number of vibrations in 24 hours.

The height of the ball of the pendulum was found by levelling, agreeing with a trigonometrical measurement, to be 115 feet; the correction due to which is $0,47 \times \frac{6}{10} = 0,28$; this together with that for the buoyancy of the atmosphere, viz. 5,74, gives 6,02 to be added to the mean number of vibrations; and we have 86125,03 for the final number of vibrations which would be made by this pendulum in vacuo at the temperature of 68°, at the level of the sea, in a mean solar day at San Blas, in latitude 21° 32′ 24″ N. and longitude 105° 15′ W.

From the above data, and the number of vibrations made by the same pendulum in London, after returning to England,* viz. 86236,95, together with the known length of the second's pendulum in London, the length of the second's pendulum at San Blas is found to be 39,03776 inches; and comparing this with the lengths of the second's pendulum determined by CAPTAIN KATER at the principal British stations, we obtain the following expressions for the diminution of gravity from the pole to the equator, and ellipticity of the earth, together with the lengths of the equatorial pendulum by each comparison.

Stations compared with San Blas, in Lat. 21° 32′ 24″ N.	Diminution of Gravity from Pole to Equator.	Ellipticity.	Length of Equat. Pendul.
Unst - in Lat. 60 45 28 N.	,0054703	$\frac{1}{314,44}$	39,00899
Portsoy - - - 57 40 59	,0054789	$\frac{1}{315,30}$	,00895
Leith - - - - 55 58 41	,0054683	$\frac{1}{314,25}$	,00901
Clifton - - - 52 27 43	,0054328	$\frac{1}{310,78}$	,00920
Arbury Hill - - 52 12 55	,0054819	$\frac{1}{315,60}$	,00893
London - - - 51 31 8	,0054452	$\frac{1}{311,98}$	,00912
Shanklin Farm - 50 37 24	,0054505	$\frac{1}{312,50}$	,00910
Mean	,0054611	$\frac{1}{313,55}$	39,00904

* See the Remarks after the Experiment given in the Appendix.

Experiment No. IV. 2nd Series at San Blas;

By Mr. H. Foster.

Comparisons of Clock with Chronometer 438, *at San Blas*; (*2nd Series.*)

Date.	Barometer.	Therm. Fahrenheit.	Time by Chronometer.	Time by Clock.	Clock fast of Chronometer.
1822,	Inches.	°	h. m. s.	h. m. s.	h. m. s.
May 26th, Noon,	29,88	86,2	4 6 51,5	12 9 0	8 2 8,5
P. M.	——	——	11 35 53,9	7 38 0	2 6,1
	——	——	1 6 54,7	9 9 0	2 5,3
	29,87	84,5	2 13 55,0	10 16 0	2 5
27th, Noon,	29,86	86,5	4 4 1,0	12 6 0	8 1 59,0
P. M.	——	——	11 31 5,1	7 33 0	1 54,9
	——	——	11 54 5,2	7 56 0	1 54,8
	——	——	12 35 5,7	8 37 0	1 54,3
	——	——	1 5 5,9	9 7 0	1 54,1
	29,82	84,8	2 12 6,5	10 14 0	1 53,5
28th, Noon,	29,79	86,2	4 4 12,0	12 6 0	8 1 48,0
P. M.	——	——	11 26 16,2	7 28 0	1 43,8
	——	——	11 48 16,5	7 50 0	1 43,5
	29,76	85,2	1 23 17,4	9 25 0	1 42,6
29th Noon,	29,77	87,0	4 3 25,9	12 5 0	8 1 34,1
P. M.	——	——	11 43 30,7	7 45 0	1 29,3
	——	——	12 24 31,0	8 26 0	1 29,0
	——	——	12 56 31,3	8 58 0	1 28,7
	——	——	1 19 32,5	9 21 0	1 28,5
	——	——	1 45 31,8	9 57 0	1 28,2
	29,78	85,0	2 3 32,0	10 5 0	1 28,0
30th, Noon.	29,78	88,0	4 4 38,9	12 6 0	8 1 21,1

Transits of Stars. (2nd Series.)

Date.	Stars.	1st. Wire	2nd. Wire.	Mer. Wire.	4th Wire.	5th Wire.	Mean Chron.	Mean Clock.
1822.		h. m. s.	m. s.	m. s.	m. s.	m. s.	h. m. s.	h. m. s.
	☉'s 1st Limb	3 57 24, 0	57 52, 0	58 19, 0	58 45, 5	59 13, 5		
May 26.	☉'s 2d Limb	3 59 29, 0	59 57, 0	0 24, 5	0 50, 5	1 18, 0		
	☉'s Centre	3 58 26,50	58 54,50	59 21,75	59 48, 0	0 15,75	3 59 21,37	12 1 29,91
						Clock at mean Noon		12 4 50,97
P. M.	γ Ursæ Maj	——	——	11 30 44, 0	31 26, 0	——	11 31 5, 0	7 33 11,13
	g ——	1 2 34, 7	3 21, 0	4 6, 5	4 50, 0	5 35, 5	1 4 5,70	9 6 11,02
	λ Bootis	1 54 14, 0	54 51, 7	55 29, 0	56 4, 5	56 42, 0	1 55 28,37	9 57 33,47
	☉'s 1st Limb	3 57 4, 5	57 32, 0	58 00, 0	56 26, 2	58 54, 0		
27	☉'s 2d Limb	3 59 16, 5	59 44, 0	0 11, 5	0 38, 0	1 5, 5		
	☉'s Centre	3 58 10,50	58 38, 0	59 5,75	59 32,10	59 59,75	3 59 5,31	12 1 4,34
						Clock at mean Noon		12 4 18,34
P. M.	γ Ursæ Maj.	11 24 56, 5	25 41, 0	26 25, 0	27 7, 2	27 51, 5	11 26 24,37	7 28 19,32
	δ ——	11 46 53, 5	47 42, 0	48 30, 5	59 16, 5	50 4, 0	11 48 29,50	7 50 24,36
	Cor Caroli	——	12 28 57, 0	29 30, 2	30 1, 5	30 34, 5	12 29 29,72	8 31 24,08
	g Ursæ Maj.	12 58 16, 5	59 2, 0	59 47, 5	00 30, 0	1 15, 5	12 59 46,50	9 1 40,66
	γ Bootis	1 49 55, 0	50 33, 0	51 10, 0	51 45, 5	52 24, 0	1 51 9,58	9 53 3,28
	θ ——	1 59 16, 0	59 58, 0	00 40, 5	1 20, 5	2 2, 0	2 0 39,58	10 2 33,20
	γ ——	2 5 19, 5	5 52, 5	6 25, 5	6 56, 5	7 30, 0	2 6 24,92	10 8 18, 48
	☉'s 1st Limb	3 56 53, 5	57 21, 0	57 49, 0	58 15, 0	58 43, 0		
28	☉'s 2d Limb	3 58 54, 0	59 21, 0	59 48, 5	00 15, 0	00 43, 0		
	☉'s Centre	3 57 53,75	58 21, 0	58 48,75	59 15, 0	59 43, 0	3 58 48,37	12 00 36,42
						Clock at Mean Noon		12 3 44,12
P. M.	γ Ursæ Maj.	11 20 36, 5	21 20, 5	22 5, 0	22 47, 2	23 31, 2	11 22 4, 23	7 23 48,07
	δ ——	11 42 34, 0	43 22, 5	44 10, 5	44 56, 5	45 45, 0	11 44 9, 84	7 45 53,38
	η ——	1 16 30, 0	17 10, 5	17 51, 0	18 28, 5	19 8, 5	1 17 49, 92	9 19 32,57
	☉'s 1st Limb	3 56 41, 5	57 8, 5	57 36, 2	58 2, 0	58 30, 0		
29	☉'s 2d Limb	3 58 38, 0	59 5, 0	59 33, 0	59 59, 0	00 27, 0		
	☉'s Centre	3 57 39,75	58 6,75	58 34, 6	59 0, 5	59 28, 5	3 58 34,11	12 0 8,26
						Clock at Mean Noon		12 3 8,36
P. M.	δ Ursæ Maj.	11 38 15, 8	39 4, 5	39 53, 5	40 38, 5	41 27, 0	11 39 52,13	7 41 21,47
	Cor Caroli	12 19 46, 0	20 19, 2	20 53, 0	21 24, 0	21 57, 0	12 20 52,03	8 22 21,07
	g Ursæ Maj.	12 49 39, 0	50 24, 0	51 10, 5	51 53, 5	52 39, 5	12 51 9,50	8 52 38,26
	η ——	1 12 14, 0	12 53, 0	13 33, 5	14 10, 5	14 51, 0	1 13 32,58	9 15 1,15
	λ Bootis.	1 41 18, 5	41 56, 0	42 33, 5	43 9, 0	43 46, 0	1 42 32,75	9 44 0,98
	θ ——	1 50 37, 2	51 22, 0	52 3, 0	52 43, 0	53 24, 5	1 52 2,12	9 53 30,24
	γ ——	1 56 42, 5	57 15, 0	57 48, 2	58 19, 5	58 52, 8	1 57 47,70	9 59 15,76
	☉'s 1st Limb	3 56 16, 0	56 44, 0	57 11, 5	58 6, 0			
30	☉'s 2d Limb	3 58 32, 0	58 59, 0	59 27, 0	00 22, 0			
	☉'s Centre	3 57 24, 0	57 51,50	58 19,25	58 45, 5	59 14, 0	3 58 18,92	11 59 40,08
						Clock at Mean Noon		12 2 32,71

Observations of Coincidences at San Blas. (2nd Series.)

May 27, A.M. Clock losing $35^s,06$ at a mean rate. Barom. 29,87.

Temp. Fahrenheit.	Time of coincidence.	Arc of Vibration.	Mean Arc.	Interval in Seconds.	No. of Vibrations.	Observed Vibrations in 24 hours.	Correction for Arc.	Vibrations in 24 hours.
°	h. m. s.	°						
81,5	6 12 53	1,32	°					
,7	24 12	1,22	1,27	679			2,64	
,9	35 32	1,13	1,17	680			2,24	
82,0	46 52	1,05	1,09	680			1,94	
,3	58 13	0,97	1,01	681			1,67	
83,0	7 9 36	0,90	0,93	683			1,42	
,5	20 58	0,83	0,86	682			1,21	
,8	32 20	0,77	0,80	682			1,05	
84,0	43 44	0,72	0,74	684			0,90	
82,6				681,37	679,37	86111,43	1,63	86113,06

May 27th. P.M. Barom. 29,80.

87,1	3 50 57	1,30						
,1	4 2 15	1,20	1,25	678			2,55	
,1	13 14	1,11	1,15	679			2,17	
,2	24 54	1,02	1,06	680			1,84	
,2	36 14	0,95	0,98	680			1,57	
,2	47 34	0,88	0,91	680			1,36	
,2	58 57	0,82	0,85	683			1,18	
,2	5 10 17	0,77	0,79	680			1,03	
,0	21 39	0,72	0,74	682			0,90	
87,1				680,25	678,25	86111,02	1,57	86112,59

May 28th. A.M. Barom. 29,80.

82,6	6 00 5	1,33						
,8	11 25	1,22	1,27	680			2,64	
,9	22 46	1,12	1,17	681			2,24	
,9	34 8	1,05	1,08	682			1,91	
83,0	45 30	0,96	1,00	682			1,64	
,2	56 52	0,90	0,93	682			1,41	
,6	7 8 16	0,83	0,86	684			1,21	
,8	19 39	0,77	0,80	683			1,05	
84,0	32 2	0,71	0,74	683			0,90	
83,1				682,12	680,12	86111,71	1,62	86113,33

May 28, P. M. Clock losing 35^s,06 at a mean rate. Barom. 29,76.								
Temp. Fahrenheit.	Time of coincidence.	Arc of Vibration.	Mean Arc.	Interval in Seconds.	No. of Vibrations.	Observed Vibrations in 24 hours.	Correction for Arc.	Vibrations in 24 hours.
°	h. m. s.	°						
87,9	3 53 32	1,34	°					
,9	4 4 52	1,24	1,29	680			2,72	
,9	16 13	1,14	1,19	681			2,31	
,9	27 34	1,05	1,09	681			1,95	
,8	38 57	0,99	1,02	683			1,70	
,8	50 19	0,92	0,95	682			1,48	
,8	5 1 42	0,85	0,88	683			1,27	
,8	13 6	0,78	0,81	684			1,08	
,7	24 31	0,72	0,75	685			0,92	
87,8				682,37	680,37	86111,80	1,68	86113,48
May 29th. A. M. Barom. 29,77.								
81,8	6 1 51	1,32						
,5	13 10	1,22	1,27	679			2,64	
,5	24 30	1,14	1,18	680			2,28	
,8	35 51	1,08	1,11	681			2,01	
82,0	47 12	1,00	1,04	681			1,77	
,2	58 34	0,92	0,96	682			1,51	
,4	7 9 57	0,87	0,89	683			1,30	
,9	21 18	0,79	0,83	681			1,12	
83,0	32 40	0,73	0,76	682			0,94	
				681,12	679,12	86111,34	1,69	86113,03
May 29th. P. M. Barom. 29,75.								
88,5	4 1 20	1,32						
,2	12 38	1,22	1,27	678			2,64	
,1	23 57	1,13	1,18	679			2,28	
,1	35 17	1,05	1,09	680			1,94	
,1	46 37	0,97	1,01	680			1,67	
1	58 57	0,90	0,93	680			1,42	
,1	5 9 19	0,84	0,87	682			1,24	
,0	20 41	0,78	0,81	682			1,07	
,0	32 5	0,72	0,75	684			0,92	
88,1				680,62	678,62	86111,16	1,65	86112,81

May 30th. A. M.						Barom. 29,78.		
Temp. Fahrenheit.	Time of coincidence.	Arc of Vibration.	Mean Arc.	Interval in Seconds.	No. of Vibrations.	Observed Vibrations in 24 hours.	Correction for Arc.	Vibrations in 24 hours.
°	h, m. s.	°						
79,8	5 58 9	1,34	°					
,8	6 9 31	1,24	1,29	682			2,72	
,8	20 52	1,15	1,19	681			2,32	
,8	32 13	1,08	1,11	681			2,02	
,8	42 34	1,00	1,04	681			1,77	
80,0	54 57	0,92	0,96	683			1,51	
,2	7 6 21	0,85	0,88	684			1,27	
81,0	17 45	0,80	0,82	684			1,10	
,0	29 7	0,75	0,77	682			0,97	
80,1				682,25	680,25	86111,76	1,71	86113,47

TABLE I. *(2d Series.)*

Times by clock at Transits of Stars.

Stars.	May 16th.	27th	28th.	29th.
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
γ Ursæ Majoris	——	7 28 19,32	7 23 48,07	——
Do. 3rd & 4th wires	7 33 11,13	7 28 41,05	7 24 9,94	——
δ Ursæ Maj. . .	——	7 50 24,36	7 45 53,38	7 41 21,47
Cor Caroli . .	——	8 31 24,08	——	8 22 21,07
g Ursæ Maj. . .	9 6 11,02	9 1 40,66	——	8 52 38,26
η Ursæ Maj. . .	——	——	9 19 32,57	9 15 1,15
λ Bootis . . .	9 57 33,47	9 53 3,28	——	9 44 0,98
θ Bootis . . .	——	10 2 33,20	——	9 53 30,24
γ Bootis . . .	——	10 8 18,48	——	9 59 15,76

TABLE II.

Transits of Sun.

Time by clock at Mean Noon, May 26.	27th.	28th.	29th.	30th.
h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.
12 4 50,97	12 4 18,34	12 3 44,12	12 3 8,66	12 2 32,71

TABLE III. *(2nd Series.)*

Rates of the Clock by the Stars' Transits. (Losing.)

Stars.	From 26 to 27	26 to 28	26 to 29	27 to 28	27 to 29	28 to 29
	s.	s.	s.	s.	s.	s.
γ Ursæ Maj. -	34,17	34,68	—	35,34	—	—
δ ——	—	—	—	35,07	35,53	36,00
Cor Caroli -	—	—	—	—	35,59	—
g Ursæ Maj. -	34,45	—	35,01	—	35,29	—
η ——	—	—	—	—	—	35,51
λ Bootis -	34,28	—	34,92	—	35,24	—
θ ——	—	—	—	—	35,57	—
γ ——	—	—	—	—	35,45	—
Mean by stars -	34,30	34,68	34,96	35,20	35,44	35,75
Proportional rate for the acceleration $3^m\ 56^s$.	+,10	+,10	+,10	+,10	+,10	+,10
Rate in a mean solar day	34,40	34,78	35,06	35,30	35,54	35,85
Mean solar Time to which the above rates are due	$8^h\ 45^m$ A. M. 27	$7^h\ 24^m$ P. M. 27	$9^h\ 21^m$ A. M. 28	$7^h\ 33^m$ A. M. 28	$9^h\ 6^m$ P. M. 28	$8^h\ 27^m$ A. M. 29

TABLE IV.

Rates by the Sun's Transits. (Clock losing.)

26 to 27	26 to 28	26 to 29	26 to 30	27 to 28	27 to 29	27 to 30	28 to 29	28 to 30	29 to 30
s.	s.	s.	s.	s.	s.	s.	s.	s.	s.
32,63	33,42	34,10	34,56	34,22	34,84	35,21	35,46	35,70	35,95
$11^h\ 55^m$ P. M. 26	$11^h\ 56^m$ A. M. 27	$11^h\ 56^m$ P. M. 27	$11^h\ 56^m$ A. M. 28	$11^h\ 56^m$ P. M. 27	$11^h\ 56^m$ A. M. 28	$11^h\ 56^m$ P. M. 28	$11^h\ 56^m$ P. M. 28	$11^h\ 57^m$ A. M. 29	$11^h\ 57^m$ P. M. 29

TABLE V. *(2d. Series.)*

Vibrations of the Pendulum at San Blas,

The Clock making 86364,94 vibrations in a mean solar day.

Date.	Barom.	Therm.	Difference of Temperature from 68°	Vibrations in 24 hours.	Corrections for Temperature.	Vibrations. in 24 hours at Temperature 68 degrees.
	Inches.	°	°		s.	
May 27, A.M.	29,87	82,6	14,6	86113,06	+ 6,18	86119,24
P.M.	29,80	87,1	19,1	86112,59	+ 8,08	86120,67
28, A.M.	29,80	83,1	15,1	86113,33	+ 6,39	86119,72
P.M.	29,76	87,8	19,8	86113,48	+ 8,37	86121,85
29, A.M.	29,77	82,1	14,1	86113,03	+ 5,96	86118,99
P.M	29,75	88,1	20,1	86112,81	+ 8,50	86121,31
30, A.M.	29,78	80,1	12,1	86113,47	+ 5,12	86118,59
Mean	29,79	84,4				86120,05

TABLE VI.

By the Stars.

	Correct Vibrations in a mean solar day.	Number of Stars observed.	Interval of Transits.	Factors.
From 27 May, A. M. to 27, P. M.	86120,61	3	1	3
28	86120,65	1	2	2
29	86120,30	2	3	6
28 A. M. to 28, P. M.	86120,54	2	1	2
29, P. M.	86119,99	6	2	12
29 A. M. to 29, P. M.	86119,36	2	1	2
Mean	86120,24	Sum of Factors		27

TABLE VII.

By the Sun.

	Correct Vibrations in a mean solar day.	Number of Stars observed.	Interval of Transits.	Factors.
From 27 May, P. M. to 28, A. M.	86121,03	2	1	2
29	86120,53	2	2	4
30	86120,04	2	3	6
28 P. M. to 29, A. M.	86120,02	2	1	2
30	86119,54	2	2	4
29 P. M. to 30, A. M.	86119,06	2	1	2
Mean by the Sun	86120,04	Sum of Factors		20

By the transits of the stars we have obtained 86120,24 vibrations made by the pendulum, and by the sun 86120,04; but the sums of the factors for the stars being 27, and those for the sun 20, we have 0,15 to add to the vibrations given by the sun to arrive at 86120,19, the mean number of vibrations in 24 hours.

The ball of the pendulum was elevated above the level of the sea 115 feet, the correction due to which is $0,47 \times \frac{6}{10} = 0,28$; this, together with 5,71, the correction for buoyancy of the atmosphere, gives 5,99 as the final sum to be added to the mean number of vibrations in 24 hours, which gives 86126,18 for the number of vibrations made by the pendulum in vacuo at the level of the sea, and temperature 68° at San Blas de California, in latitude 21° 32′ 24″ N, longitude 105° 15′ West.

From the above data, and the length of the second's pendulum in London, determined after the return,* the length of the second's pendulum at San Blas appears to be 39,03881 inches, and comparing this with the lengths ascertained at different places, by Captain KATER, we obtain the following results:—

Stations compared with San Blas, in Lat. 21° 32′ 24″ N.	Diminution of Gravity from Pole to Equator.	Ellipticity.	Length of the Equat. Pend.
Unst - in Lat. 60 45 28 N.	,0054273	$\frac{1}{310,25}$	39,01026
Portsoy - - - 57 40 59	,0054323	$\frac{1}{310,73}$	,01024
Leith Fort - - 55 58 41	,0054193	$\frac{1}{309,48}$	,01031
Clifton - - - 52 27 43	,0053799	$\frac{1}{305,75}$	,01052
Arbury Hill - - 52 12 55	,0054268	$\frac{1}{310,21}$	,01027
London - - - - 51 31 8	,0053888	$\frac{1}{306,59}$	,01047
Shaklin Farm - 50 37 24	,0053923	$\frac{1}{306,92}$	,01045
Mean	,0054095	$\frac{1}{308,56}$	39,01036

* See Remarks after the Experiment given in the Appendix.

Experiment No. V. at Rio de Janeiro.

1st *Series.* *By Captain* Hall.

Comparisons of Clock with Chronometer 438 *at Rio de Janeiro.*

Date.	Barom.	Therm.	Chronometer.	Clock.	Difference.
1822.	Inches.	°	h. m. s.	h. m. s.	Clock Fast. m. s.
Sept. 28 Noon.	29,86	72	11 19 50,00	11 49 0,0	29 10,00
29	29,92	73	11 13 10,00	11 42 0,0	28 50,00
P. M.			5 8 15,00	5 37 0,0	28 45, 0
			6 35 16, 0	7 4 0,0	28 44, 0
30	29,88	74	11 24 29, 5	11 53 0,0	28 30, 5
P. M.			4 55 34, 5	5 24 0,0	28 25, 5
			6 7 35, 5	6 36 0,0	28 24, 5
Oct. 1.	29,81	74½	11 30 51, 5	12 9 0,0	28 8, 5
P. M.			6 39 58, 5	7 8 0,0	28 1, 5
			7 41 59, 5	8 10 0,0	28 0, 5
2	29,82	75	11 16 14, 5	11 44 0,0	27 45, 0
4	30,00	71,9	11 8 53, 5	11 36 0,0	27 6, 5
5	29,90	71,90	11 9 12, 5	11 36 0,0	26 47, 5
P. M.			5 20 17, 5	5 47 0,0	26 42, 5
			5 47 18, 0	6 14 0,0	26 42, 0
			7 36 19, 5	8 3 0,0	26 40, 5

Transits of Stars at Rio de Janeiro. (1st Series.)

Date.	Stars.	1st Wire.	2nd Wire.	Mer. Wire.	4th Wire.	5th Wire.	Mean Chron.	Mean Clock.	
		h. m. s.	m. s.	m. s.	h. m. s.	m. s.	h. m. s.	h. m. s.	
1822. Sept. 28	⊙'s 1st Limb	11 4 52,75	5 19,00	5 43,00	6 8,50	6 34,00			
	⊙'s 2d Limb	11 7 1,00	7 27,25	7 52,00	8 17,50	8 43,00			
	⊙'s Centre	11 5 56,87	6 23,12	6 47,50	7 13,00	7 38,50	11 6 47,75	11 35 57,92	
							Clock at mean Noon	11 45 13,72	
29	⊙'s 1st Limb	11 4 12,00	4 38,00	5 2,75	5 28,00	5 53,50			
	⊙'s 2d Limb	11 6 21,25	6 46,75	7 11,50	7 36,75	8 3,00			
	⊙'s Centre	11 5 16,62	5 42,37	6 7,12	6 32,37	6 58,25	11 6 7,31	11 34 57,40	
							Clock at mean Noon	11 44 33,15	
P. M.	α Lyræ -	—	—	—	5 14 55, 0	15 29, 0	5 15 12,00	5 43 56,91	Mean of 4th and 5th wires.
	β —	5 25 57,00	26 27,75	26 57,25	27 27,50	27 58,62	5 26 57,56	5 55 42,34	
	γ —	5 34 42,50	35 13,25	35 42,50	36 12,50	36 43,25	5 35 42,74	6 4 27,44	
	κ Cygni -	5 54 56,25	55 39,00	56 20,25	57 2,00	—	5 55 59,37	6 24 43,90	Mean of four first wires κ Cygni.
	κ Cygni -	5 54 56,25	—	56 20,25	—	—	5 55 38,25	6 24 22,78	Mean of 1st and Mer. wire κ Cygni.
	γ Aquilæ -	6 20 14,25	20 40,75	21 5,25	21 31,50	21 57,50	6 21 5,75	6 49 49,95	
	α Aquilæ -	6 24 32,00	24 58,00	25 22,75	25 48,75	26 14,50	6 25 23,12	6 54 7,28	
30	⊙'s 1st Limb	11 3 31,00	3 57, 0	4 21,00	4 47,00	5 12,50			
	⊙'s 2d Limb	11 5 39,75	6 5,75	6 30,50	6 56,12	7 21,62			
	⊙'s Centre	11 4 35,37	5 1,37	5 25,75	5 51,56	6 17,06	11 5 26,14	11 33 56,89	
							Clock at mean Noon	11 43 52,21	
P. M.	α Lyræ -	5 9 1,25	9 34,62	10 6,12	10 39,00	11 12,00	5 10 6,52	5 38 31,81	
	Ditto	—	—	—	10 39,00	11 12,00	5 10 55,50	5 39 20,79	Mean of 4th and 5th wires α Lyræ.
	β Lyræ -	5 21 39,62	22 10,50	22 39,62	23 10,50	23 41,25	5 22 40,18	5 51 5,30	
	Lyræ -	5 30 25,50	30 56,00	31 25,00	31 55,25	32 26,00	5 31 25,46	5 59 50,46	
	A Star -	5 38 48,75	39 19,50	39 48,75	40 18,50	40 49,12	5 39 48,89	6 8 13,77	
	κ Cygni -	5 50 38,25	—	52 2,25	—	—	5 51 20,25	6 19 45,00	Mean of 1st and mer. wires κ Cygni.
	β Cygni -	6 1 38,50	2 7,50	2 35,00	3 3,75	3 33,25	6 2 35,50	6 31 00,05	
	γ Aquilæ -	6 15 57,25	16 23,62	16 48,50	17 14,75	17 41,12	6 16 48,95	6 45 13,33	
	α Aquilæ -	6 20 14,50	20 41,00	21 5,62	21 31,62	21 57,75	6 21 6,02	6 49 30,32	
	β —	6 24 42,25	25 8,50	25 33,37	25 59,12	26 25,00	6 25 33,60	6 53 57,84	
	γ Cygni -	6 53 38,25	54 12,00	54 43,75	55 16,87	55 50,00	6 54 44,10	7 23 7,92	

Transits of Stars at Rio de Janeiro continued. (1st Series.)

Date.	Stars.	1st Wire.	2nd Wire.	Mer. Wire.	4th Wire.	5th Wire.	Mean Chron.	Mean Clock.	
1822.		h. m. s.	m. s.	m. s.	m. s.	m. s.	h. m. s.	h. m. s.	
	☉'s 1st Limb	11 2 52,20	3 18,00	3 43, 0	4 8,20	4 34,00			
Oct. 1	☉'s 2d Limb	11 5 00,75	5 27,50	5 51,50	6 17,50	6 43,00			
	☉'s Centre	11 3 56,47	4 22,75	4 47,25	5 12,85	5 38,50	11 4 47,51	11 32 56,34	
							Clock at mean Noon	11 43 10,93	
P. M.	A Star -	5 34 34, 0	35 3,70	35 33, 0	36 4,00	36 34,00	5 35 33,62	6 3 36,02	
	κ Cygni -	5 46 24, 0	47 7,00	47 48,00	48 30,20	——	5 47 27,30	6 15 29,50	Mean of four first wires κ Cygni.
	Ditto	5 46 24, 0	——	47 48,00	——	——	5 47 6,00	6 15 8,20	Mean of 1st and mer. wires κ Cygni.
	β Cygni -	5 57 24, 0	57 53,00	58 20,50	58 49,00	59 18,00	5 58 20,92	6 26 22,97	
	γ Aquilæ -	6 11 42,50	12 9,00	12 33,50	12 59,50	13 26,00	6 12 34,00	6 40 35,77	
	α Aquilæ -	6 16 00, 0	16 26,00	16 51,00	17 17,00	17 43,00	6 16 51,33	6 44 53,05	
	β Aquilæ -	6 20 28,00	20 54,00	21 18,50	21 44,00	22 10,00	6 21 18,83	6 49 20,50	
	γ Cygni -	6 49 24,25	49 57,62	50 29,62	51 2,75	51 36,00	6 50 29,97	7 18 31,24	
	☉'s 1st Limb	11 2 15,70	2 41,50	3 6,20	3 32,00	3 57,50			
2	☉'s 2d Limb	11 4 25,00	4 50,50	5 14,50	5 40,00	6 6,50			
	☉'s Centre	11 3 20,35	3 46,00	4 10,35	4 36,25	5 2,00	11 4 10,88	11 31 56,55	
							Clock at mean Noon	11 42 30,21	
	☉'s 1st Limb	11 0 57,00	1 22,50	1 47,50	2 13,25	2 39,00			
4	☉'s 2d Limb	11 3 6,25	3 32,50	3 56,62	4 22,25	4 48,62			
	☉'s Centre	11 2 1,62	2 27,50	2 52,06	3 17,75	3 43,81	11 2 52,46	11 29 59,04	
							Clock at mean Noon	11 41 9,81	
	☉'s 1st Limb	11 0 17,50	0 44,00	1 8,12	1 34,00	1 59,50			
5	☉'s 2d Limb	11 2 27,00	2 53,12	3 17,50	3 43,25	4 9,12			
	☉'s Centre	11 1 22,25	1 48,56	2 12,81	2 38,63	3 4,31	11 2 13,23	11 29 00,83	
							Clock at mean Noon	11 40 29,65	
P. M.	α Lyræ -	4 47 42,25	48 15,50	48 46,62	49 19,50	49 52,50	4 48 47,16	5 15 30,11	
	γ Aquilæ -	5 54 37,75	55 4,00	55 29,12	55 55,00	56 21,12	5 55 29,35	6 22 11,25	
	α Aquilæ -	5 58 55,25	59 21,75	59 46,50	60 12,00	60 38,25	5 59 46,71	6 26 28,56	
	β Aquilæ -	6 3 24,00	3 49,00	4 14,00	4 39,50	5 5,00	6 4 14,25	6 30 56,05	
	γ Cygni -	6 32 19,00	32 53,00	33 24,62	33 57,75	34 31,12	6 33 25,02	7 00 6,37	
	α Lyræ -	——	——	——	49 19,50	49 52,50	4 49 36,00	5 16 18,95	Mean of 4th and 5th wires α Lyræ.

Observations of Coincidences at Rio de Janeiro. (*1st Series.*)

Temp. Fahrenheit.	Time of coincidence.	Arc of Vibration.	Mean Arc.	Interval in Seconds.	No. of Vibrations.	Observed Vibrations in 24 hours.	Correction for Arc.	Vibrations in 24 hours.
P. M. 28th Sept. 1822. Clock losing at a mean rate 40^s,58.						Barom. 29,87.		
°	h. m. s.	°						
72,6	12 37 34	1,37	°					
	49 38	1,27	1,32	724			2,85	
	1 1 43	1,17	1,22	725			2,43	
	13 50	1,08	1,12	727			2,07	
	25 58	1,00	1,04	728			1,77	
	38 6	0,92	0,96	728			1,51	
	50 14	0,84	0,88	728			1,27	
	2 2 24	0,77	0,80	730			1,06	
72,4	14 35	0,71	0,74	731			0,89	
72,5				727,62	725,62	86122,05	1,73	86123,78
A.M 29th Sept.						Barom. 29,93.		
72,5	9 34 32	1,30						
	46 37	1,20	1,25	725			2,55	
	58 44	1,10	1,15	727			2,16	
	10 10 52	1,00	1,05	728			1,80	
	23 00	0,92	0,96	728			1,51	
	35 9	0,85	0,88	729			1,27	
	47 19	0,78	0,81	730			1,08	
	59 30	0,72	0,75	731			0,92	
72,8	11 11 41	0,68	0,70	731			0,80	
72,7				728,62	726,62	86122,37	1,51	86123,88
P. M. 29th September.						Barom. 29,87.		
73	12 42 54	1,36						
	54 59	1,25	1,30	725			2,78	
	1 7 5	1,16	1,20	726			2,37	
	19 11	1,06	1,11	726			2,01	
	31 19	0,97	1,01	728			1,68	
	43 27	0,90	0,93	728			1,42	
	55 37	0,83	0,86	730			1,22	
	2 7 47	0,76	0,79	730			1,03	
73	19 56	0,72	0,74	729			0,89	
73				727,75	725,75	86122,08	1,67	86123,75

A. M. September 30th. Barom. 29,90.

Temp. Fahrenheit.	Time of coincidence.	Arc of Vibration.	Mean Arc.	Interval in Seconds.	No. of Vibrations.	Observed Vibrations in 24 hours.	Correction for Arc.	Vibrations in 24 hours.
	h. m. s.	°						
73,2	10 13 44	1,38	°					
	25 48	1,27	1,32	724			2,86	
	37 53	1,17	1,22	725			2,43	
	49 58	1,08	1,12	725			2,06	
	11 2 5	0,99	1,03	727			1,75	
	14 14	0,91	0,95	729			1,48	
	26 22	0,84	0,87	728			1,25	
	38 31	0,78	0,81	729			1,07	
74,0	50 40	0,72	0,75	729			0,92	
73,6				727	725	86121,84	1,73	86123,57

P. M. 30th September. Barom. 29,85.

74	1 4 50	1,39						
	16 53	1,29	1,29	723			2,74	
	28 57	1,19	1,24	724			2,51	
	41 2	1,09	1,14	725			2,12	
	53 9	0,99	1,01	726			1,68	
	2 5 17	0,91	0,95	728			1,48	
	17 25	0,81	0,87	728			1,25	
	29 34	0,78	0,81	729			1,07	
74	41 43	0,73	0,75	729			0,93	
74				726,5	724,5	86121,68	1,72	86121,40

A. M. 1st October. Barom. 29,80.

74,0	9 29 38	1,42						
	41 40	1,31	1,36	722			3,04	
	53 45	1,21	1,25	725			2,57	
	10 5 50	1,11	1,15	725			2,18	
	17 57	1,02	1,06	727			1,81	
	30 5	0,94	0,98	728			1,57	
	42 14	0,85	0,89	729			1,30	
	54 23	0,78	0,81	729			1,08	
74,5	11 6 32	0,74	0,76	729			0,94	
74,2				726,75	724,75	86121,76	1,81	86123,57

P. M. 1st Oct. Clock losing at a mean rate 40^s,58. Barom. 29,78.

Temp. Fahrenheit.	Time of coincidence.	Arc of Vibration.	Mean Arc.	Interval in Seconds.	No. of Vibrations.	Observed Vibrations in 24 hours.	Correction for Arc.	Vibrations in 24 hours.
	h. m. s.							
74°,6	1 2 40	1°,36						
	14 44	1,25	1°,30	724			2,78	
	26 49	1,15	1,20	725			2,35	
	38 55	1,06	1,10	726			2,00	
	51 0	0,98	1,02	725			1,70	
	2 3 7	0,90	0,94	727			1,44	
	15 15	0,83	0,86	728			1,22	
	27 24	0,77	0,80	729			1,05	
74,7	39 33	0,72	0,74	729			0,91	
74,7				726,62	724,62	86121,72	1,68	86123,40

2d October, A. M. Barom. 29,82.

75	9 58 43	1,38						
	10 10 45	1,27	1,32	722			2,86	
	22 49	1,16	1,21	724			2,41	
	34 53	1,06	1,11	724			2,01	
	46 58	0,98	1,02	725			1,70	
	59 3	0,90	0,94	725			1,44	
	11 11 10	0,83	0,86	727			1,22	
	23 17	0,78	0,81	727			1,08	
75	35 25	0,73	0,75	728			0,93	
75				725,25	723,25	86121,27	1,71	86122,98

P. M. 2d October. Barom. 29,80.

75	12 53 58	1,35						
	1 6 1	1,24	1,29	723			2,74	
	18 3	1,14	1,19	722			2,31	
	30 7	1,05	1,09	724			1,95	
	42 13	0,95	1,00	726			1,63	
	54 18	0,87	0,91	725			1,35	
	2 6 25	0,81	0,84	727			1,15	
	18 33	0,76	0,78	728			1,01	
75	30 40	0,71	0,73	727			0,88	
75				725,25	723,25	86121,27	1,63	86122,90

3d October, A. M. Barom. 30,02.

Temp. Fahrenheit.	Time of coincidence.	Arc of Vibration.	Mean Arc.	Interval in Seconds.	No. of Vibrations.	Observed Vibrations in 24 hours.	Correction for Arc.	Vibrations in 24 hours.
°	h. m. s.	°						
73	10 1 51	1,37	°					
	13 54	1,27	1,32	723			2,85	
	25 59	1,17	1,22	725			2,43	
	38 5	1,08	1,12	726			2,06	
	50 12	0,99	1,03	727			1,74	
	11 2 18	0,91	0,95	726			1,48	
	14 26	0,84	0,87	728			1,25	
	26 36	0,77	0,80	730			1,06	
73	38 45	0,71	0,74	729			0,89	
73				726,75	724,75	86121,76	1,72	86123,48

3d October, P. M. Barom. 29,99.

Temp. Fahrenheit.	Time of coincidence.	Arc of Vibration.	Mean Arc.	Interval in Seconds.	No. of Vibrations.	Observed Vibrations in 24 hours.	Correction for Arc.	Vibrations in 24 hours.
72,7	12 47 42	1,34						
	59 45	1,23	1,28	723			2,70	
	1 11 49	1,13	1,18	724			2,28	
	23 56	1,03	1,08	727			1,91	
	36 4	0,94	0,97	728			1,54	
	48 11	0,87	0,90	727			1,34	
	2 0 21	0,80	0,83	730			1,13	
	12 29	0,74	0,77	728			0,97	
72	24 39	0,69	0,71	730			0,84	
72,3				727,12	725,12	86121,88	1,59	86123,47

4th October, A. M. Barom. 30,00.

Temp. Fahrenheit.	Time of coincidence.	Arc of Vibration.	Mean Arc.	Interval in Seconds.	No. of Vibrations.	Observed Vibrations in 24 hours.	Correction for Arc.	Vibrations in 24 hours.
71,3	9 0 25	1,41						
	12 29	1,30	1,35	724			3,00	
	24 35	1,20	1,25	726			2,55	
	36 42	1,10	1,15	727			2,16	
	48 50	1,01	1,05	728			1,82	
	10 00 59	0,93	0,97	729			1,54	
	13 7	0,86	0,89	728			1,31	
	25 17	0,80	0,83	730			1,12	
71,8	37 25	0,74	0,77	728			0,97	
71,5				727,50	725,50	86122,01	1,81	86123,82

Temp. Fahrenheit.	Time of coincidence.	Arc of Vibration.	Mean Arc.	Interval in Seconds.	No. of Vibrations.	Observed Vibrations in 24 hours.	Correction for Arc.	Vibrations in 24 hours.
4th Oct. P. M. Clock losing at a mean rate 40ˢ,58. Barom. 29,96.								
°	h. m. s.	°						
72,2	12 1 45	1,38	°					
	13 50	1,28	1,33	725			2,89	
	25 55	1,18	1,25	725			2,55	
	38 2	1, 9	1,13	727			2,10	
	50 9	1, 0	1,04	727			1,78	
	1 2 17	0,92	0,96	728			1,51	
	14 26	0,85	0,88	729			1,28	
	26 35	0,79	0,82	729			1,10	
71,7	38 46	0,73	0,76	731			0,94	
72,0				727,62	725,62	86122,05	1,77	86123,82
5th October, A. M. Barom. 29,93.								
71,2	9 11 45	1,37						
	23 51	1,27	1,32	726			2,85	
	35 58	1,17	1,22	727			2,43	
	48 6	1,08	1,12	728			2,07	
	10 0 15	0,99	1,03	729			1,75	
	12 24	0,91	0,95	729			1,48	
	24 33	0,83	0,87	729			1,24	
	36 44	0,77	0,80	731			1,05	
71,6	48 55	0,71	0,74	731			0,89	
71,4				728,75	726,75	86122,41	1,72	86124,13
5th October, P. M. Barom. 29,86.								
72	12 10 50	1,37						
	22 54	1,27	1,32	724			2,85	
	35 00	1,16	1,21	726			2,41	
	47 07	1,07	1,11	727			2,03	
	59 15	0,98	1,02	728			1,72	
	11 23	0,90	0,94	728			1,44	
	23 32	0,82	0,86	729			1,21	
	35 42	0,77	0,79	730			1,03	
72,3	47 50	0,71	0,74	730			0,89	
72,2				727,75	725,75	86122,08	1,70	86123,78

TABLE I. *(1st Series.)*

Time by Clock of Transits of Stars at Rio de Janeiro.

Stars.	Time by clock, 29th Sept.	Time by clock, 30th.	Time by clock, 1st. Oct.	Time by clock, 5th.
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
α Lyræ . . .	——	5 38 31,81	——	5 15 30,11
Do. 4th & 5th wires	5 43 56,91	39 20,79	——	5 16 18,95
β Lyræ . . .	5 55 42,34	51 5,30	——	——
γ Lyræ . . .	6 4 27,44	59 50,46	——	——
A Star.	——	6 8 13,77	6 3 36,02	——
κ Cygni 4 1st wires	6 24 43,90	——	6 15 29,50	——
Do. 1st and 3d wires	6 24 22,78	6 19 45,00	6 15 8,20	——
β Cygni . . .	——	6 31 0,05	6 26 22,97	——
γ Aquilæ . . .	6 49 49,95	6 45 13,33	6 40 35,77	6 22 11,25
α Aquilæ . . .	6 54 7,28	6 49 30,32	6 44 53,05	6 26 28,56
β Aquilæ . . .	——	6 53 57,84	6 49 20,50	6 30 56,05
γ Cygni . . .	——	7 23 7,92	7 18 31,24	7 00 06,37

TABLE II.

Transits of the Sun.

Time by Clock at the moment of mean Noon.

28th Sept.	29th.	30th.	1st Oct.	2nd.	4th.	5th.
h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.
11 45 13,72	11 44 33,15	11 43 52,21	11 43 10,93	11 42 30,21	11 41 9,81	11 40 29,65

TABLE III. (1st Series.)

Rate of the Clock by the Stars Transits. (Losing.)

Stars.	From 29th to 30th Sept.	29th to 1st Oct.	29th to 5th.	30th to 1st Oct.	30th to 5th.	1st to 5th.
	s.	s.	s.	s.	s.	s.
α Lyræ	—	—	—	—	40,43	—
Do. 4th & 5th wires	40,21	—	40,42		—	—
β Lyræ	41,13	—	—		—	—
γ Lyræ	41,07	—	—		—	—
A Star . . .	—	—	—	41,84	—	—
κ Cygni 4 first wires	—	41,29	—		—	—
Do. 1st & 3d wires	41,87	—	—	40,89	—	—
β Cygni	—	—	—	41,17	—	—
γ Aquilæ . . .	40,71	41,18	40,54	41,65	40,51	40,22
α Aquilæ . . .	41,05	41,20	40,54	41,36	40,44	40,21
β Aquilæ . . .	—	—	—	41,43	40,45	40,20
γ Cygni	—	—	—	40,77	40,40	40,31
Mean by Stars .	41,01	41,22	40,50	41,30	40,45	40,23
Proportion for rate in $3^m\ 56^s$	+,11	+,11	+,11	+,11	+,11	+,11
Rate in a Mean Solar Day .	41,12	41,33	40,61	41,41	40,56	40,34

TABLE IV.

Rate by Sun's Transits. (Clock losing.)

28 to 29	28 to 30	28 to 1 Oct.	28 to 2	28 to 4	28 to 5	29 to 30	29 to 1	29 to 2	29 to 4	29 to 5	30 to 1	30 to 2	30 to 4	30 to 5	1 to 2	1 to 4	1 to 5	2 to 4	2 to 5	4 to 5
s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.
40,57	40,75	40,93	40,88	40,65	40,58	40,94	41,11	40,98	40,67	40,58	41,28	41,0	40,60	40,51	40,72	40,37	40,32	40,20	40,19	40,16

TABLE V. (1*st. Series.*)

Vibrations of the Pendulum at Rio de Janeiro.

The clock making 86359,42 Vibrations in a mean solar day, at a mean rate.

Date.		Barom.	Therm.	Difference of Temperature from 68°	Vibrations in 24 hours.	Corrections for Temperature.	Vibrations. in 24 hours in Temp. 68.
1822.		Inches.	°				
Sept. 28	P. M.	29,87	72,5	4,5	86123,78	+1,90	86125,68
29	A. M.	29,93	72,7	4,7	86123,88	+1,99	86125,87
	P. M.	29,87	73,0	5,0	86123,75	+2,11	86125,86
30	A. M.	29,90	73,6	5,6	86123,57	+2,37	86125,94
	P. M.	29,85	74,0	6,0	86123,40	+2,54	86125,94
Oct. 1	A. M.	29,80	74,2	6,2	86123,57	+2,62	86126,19
	P. M.	29,78	74,7	6,7	86123,40	+2,83	86126,23
2	A. M.	29,82	75,0	7,0	86122,98	+2,96	86125,94
	P. M.	29,80	75,0	7,0	86122,90	+2,96	86125,86
3	A. M.	30,02	73,0	5,0	86123,48	+2,11	86125,59
	P. M.	29,99	72,3	4,3	86123,47	+1,82	86125,29
4	A. M.	30,00	71,5	3,5	86123,82	+1,48	86125,30
	P. M.	29,96	72,0	4,0	86123,82	+1,69	86125,51
5	A. M.	29,93	71,4	3,4	86124,13	+1,44	86125,57
	P. M.	29,86	72,2	4,2	86123,78	+1,78	86125,56
	Mean	29,89	73,1				86125,76

TABLE VI. (1*st. Series.*)

By the Stars.

From	To	Correct Vibrations in a mean solar day.	No. of Stars observed.	Interval of Seconds.	Sum of the Factors.
Sept. 1822.					
30th A. M.	30th P. M.	86125,40	5	1	6
	1st P. M.	86125,32	3	2	6
	5th P. M.	86125,71	3	6	18
1st A. M.	1st P. M.	86125,38	7	1	7
	5th P. M.	86125,72	5	5	25
2nd A. M.	5th P. M.	86125,82	4	4	16
	Mean by Stars	86125,56	Sum of the Factors		78

TABLE VII. (1*st Series.*)

By the Sun.

From	To	Correct Vibrations in a mean solar day.	No. of Stars observed.	Interval of Transits.	Sum of the Factors.
Sept. 1822.					
28 P.M.	29 A.M.	86125,78	2	1	2
	30 A.M.	86125,67	2	2	4
	1 Oct. A.M.	86125,56	2	3	6
	2	86125,66	2	4	8
	4	86125,74	2	6	12
	5	86125,77	2	7	14
29 P.M.	30 A.M.	86125,54	2	1	2
	1 Oct. A.M.	86125,45	2	2	4
	2	86125,62	2	3	6
	4	86125,72	2	5	10
	5	86125,77	2	6	12
30 P.M.	1 Oct. A.M.	86125,36	2	1	2
	2	86125,65	2	2	4
	4	86125,77	2	4	8
	5	86125,81	2	5	10
1 Oct. P.M.	2 A.M.	86125,94	2	1	2
	4 A. M.	86125,91	2	3	6
	5	86125,92	2	4	8
2 P.M.	4 A. M.	86125,89	2	2	4
	5	86125,91	2	3	6
4 P.M.	5 A. M.	86125,96	2	1	2
Mean by Sun		86125,73	Sum of the Factors		132

Observations for the Latitude.

By the Sun.

15th October, 1822. Face East.

Barometer 29,89. Thermometer 76°

	°	′	″
Readings 1st Vernier .	14	20	15
Readings 2nd ditto .	14	21	12
		41	27
Observ^d M. Z.D. ☉'s L. L.	14	20	43,5
Semidiameter .	—	16	4,9
Z. D. ☉'s Centre . .	14	4	38,6
Refraction . .	+		13,8
Parallax . .	—		2,1
☉'s Mer. Z.D. . . .	14	4	50,3
☉'s Declination . . .	8	49	52,2 S.
Latitude, Face East .	22	54	42,5 S.

21st October 1822. Face West.

Barometer 29,88. Thermometer 78°.

	°	′	″
Readings 1st Vernier .	77	26	38
Readings 2nd ditto . .	77	27	23
		54	1
Observed Mer. Altitude	77	27	0,5
☉'s Semi Diameter . .	+	16	6,5
Apparent Alt. ☉'s Centre	77	43	7
Refraction . .	—	0	12,3
Parallax . .	+		2,
True Alt. of ☉'s Centre	77	42	56,7
☉'s True Mer. Z. Dist.	12	17	3,3
☉'s Declination . . .	10	38	59,1 S.
Latitude, Face West .	22	56	2,4 S.

	°	′	″
Latitude, Face East . . .	22	54	42, 5
——— West . . .	22	56	2, 4
Latitude of Observatory .	22	55	22,45 South.

We have thus obtained 86125,56 vibrations by the stars, and 86125,73 by the sun; the sums of the factors being respectively 78 and 132, we may take 86125,66 as the final mean number of vibrations made by the pendulum in 24 hours.

The height of the pendulum above the level of low water was found by levelling 72 feet; the correction due to which is ,293; and as the ground beneath and immediately round the pendulum was granite, and sloping rapidly to the sea, it may be multiplied by $\frac{60}{100}$, which gives ,18 as the correction for the elevation.

The correction for buoyancy is 5,86, which added to ,18, gives 6,04 as the ultimate correction to be added to 86125,66; and thus we obtain 86131,70 for the number of vibrations this pendulum would have made in vacuo at the level of the sea, in temp. of 68° of FAHRENHEIT in a mean solar day at Rio de Janeiro in latitude 22° 55′ 22″, longitude 43° W.

From the foregoing data, and the number of vibrations made at the level of the sea in London by the same pendulum, on the return to England,* viz. 86236,95, and 39,13929 inches the length of the second's pendulum in London, we arrive at the length of the second's pendulum at Rio de Janeiro 39,04381 inches, whence the following results are deduced.

Stations compared with Rio de Janeiro, in Latitude 22° 55′ 22″ S.	Diminution of Gravity from the Pole to the Equator.	Ellipticity.	Length of Equat. Pend.
Unst . . in Lat. 60° 45′ 28″ N.	,0053671	$\frac{1}{304,55}$	39,01204
Portsoy 57 40 59	,0053672	$\frac{1}{304,57}$	,01204
Leith Fort 55 58 41	,0053508	$\frac{1}{303,06}$	,01214
Clifton 53 27 43	,0053042	$\frac{1}{298,84}$	,01242
Arbury Hill . . . 52 12 55	,0053495	$\frac{1}{302,94}$	,01215
London 51 31 8	,0053079	$\frac{1}{299,16}$	,01240
Shanklin Farm . . 50 37 24	,0053087	$\frac{1}{299,24}$	,01239
Mean	,0053365	$\frac{1}{301,77}$	39,01223

* See Remarks after the Experiment, in the Appendix.

Experiment No. VI. *Second Series, at Rio de Janeiro. By Mr.* HENRY FOSTER.

Transits observed at Rio de Janeiro.

Date.	Stars.	1st Wire.	2nd Wire.	3rd Wire.	4th Wire.	5th Wire.	Mean Chronometer.	Clock.
1822.		h. m. s.	h. m. s.	h. m. s.	h. m s.	m. s.	h. m. s.	h. m. s.
Oct. 22	α Cygni -	5 38 55,25	39 32,75	40 6, 0	40 42,75	41 19, 0	5 40 6,96	5 0 24, 0
	ξ Cygni -	6 1 59,50	2 34,75	3 8,50	3 43,25	4 19, 0	6 3 8,92	5 23 25,60
	Ditto -	6 9 4,50	9 33,75	10 2,50	10 31,40	11 0,50	6 10 2,52	5 30 19,10
	e Pegasi -	6 17 36,75	18 3,50	18 30,25	18 57,50	19 24,50	6 18 30,46	5 38 46,91
	ditto ——	——	——	18 30,25	18 57,50	19 24,50	6 18 57,42	5 39 13,87
	ι ——	6 39 11,25	39 37, 0	40 1,25	40 28, 0	40 53,50	6 40 2,04	6 00 18,13
	t ——	7 2 20, 0	2 48,50	3 15, 0	3 43,25	4 11,75	7 3 15,58	6 23 31,30
	η ——	——	7 38 36,50	39 5, 0	39 34,75	40 4,25	7 39 20,12	6 59 35,30
	μ ——	——	——	——	7 46 16,50	——	7 46 16,50	7 6 31,55
	☉'s 1st Limb	10 49 57, 0	50 23,25	50 49, 0	51 15, 0	51 41, 0		
23	☉'s 2d Limb	10 52 9, 0	52 34, 0	52 59, 0	53 26, 0	53 52,25		
	☉'s Centre	10 51 3, 0	51 28,62	51 54, 0	52 20,50	52 46,62	10 51 54,46	10 11 56,83
						Clock at	mean Noon =	10 27 26,78
P.M.	α Cygni -	5 34 39,50	35 15, 0	35 49,50	36 25,70	37 1,50	5 35 50,12	4 55 47,04
	ζ ——	6 4 46,50	5 16, 0	5 44,80	6 14, 0	6 43, 0	6 5 44,85	5 25 41,31
	e Pegasi -	——	——	6 14 12,50	14 39,50	15 6,50	6 14 39,50	5 34 35,83
	ι ——	6 34 53, 0	35 19,50	35 44,50	36 10,50	36 36,50	6 35 44,75	5 55 40,76
	t ——	6 58 1,50	58 30, 0	58 57, 0	59 25, 0	59 53,50	6 58 57,33	6 18 52,99
	η ——	——	7 34 19,50	34 47,50	35 18, 0	35 47, 0	7 35 3, 0	6 54 57,96
	μ ——	——	——	——	7 41 59,50	——	7 41 59,50	7 1 54,36
	Ditto	——	——	7 41 31,50	41 59,50	——	7 41 45,50	7 1 40,36
	β ——	7 54 16,50	54 45,50	55 13, 0	55 42, 0	56 10, 0	7 55 13,33	7 15 7,99
	☉'s 1st Limb	10 49 29, 0	49 55,20	50 20, 0	50 46,50	51 13, 0		
24	☉'s 2d Limb	10 51 41, 0	52 7,50	52 32,50	52 58,50	53 25, 0		
	☉'s Centre	10 50 35, 0	51 1,35	51 26,25	51 52,50	52 19, 0	10 51 26,72	10 11 7,17
						Clock at	mean Noon =	10 26 44,94
	☉'s 1st Limb	10 48 32, 0	48 59, 0	49 24,20	49 50, 0	50 16,50		
26	☉'s 2d Limb	10 50 45,50	51 11,80	51 37, 0	52 3, 0	52 29,50		
	☉'s Centre	10 49 38,75	50 5,40	50 30,60	50 56,50	51 23, 0	10 50 30,81	10 9 30,48
						Clock at	mean Noon =	10 25 21,88

Transits observed at Rio de Janeiro. (2nd Series.)

Date.	Stars.	1st Wire.	2nd Wire.	3rd Wire.	4th Wire.	5th Wire.	Mean Chronometer.	Clock.
1822.		h. m. s.	h. m. s.	h. m. s.	h. m. s.	m. s.	h. m. s.	h. m. s.
Oct. 28	⊙'s 1st Limb	10 47 35, 0	48 2, 0	48 27, 0	48 53,20	49 19,80		
	⊙'s 2d Limb	10 49 48, 0	50 14,70	50 40, 0	51 6, 0	51 32,50		
	⊙'s Centre	10 48 41,50	49 8,35	49 33 50	49 59,60	50 26,15	10 49 33,76	10 7 56,76
						Clock at mean Noon =		10 23 58,88
29	⊙'s 1st Limb	10 47 6,50	47 33,50	47 59, 0	48 25, 0	48 51,20		
	⊙'s 2d Limb	10 49 20,50	49 47, 0	50 12, 0	50 38,20	51 5, 0		
	⊙'s Centre	10 48 13,50	48 40,25	49 5,50	49 31,60	49 58,10	10 49 5,76	10 7 10,35
						Clock at mean Noon =		10 23 16,68
30	⊙'s 1st Limb	10 46 40, 0	47 7, 0	47 32,80	47 59, 0	48 25, 0		
	⊙'s 2d Limb	10 48 54, 0	49 20,50	49 46, 0	50 12,50	50 39, 0		
	⊙'s Centre	10 47 47, 0	48 13,75	48 39,40	49 5,75	49 32, 0	10 48 39,55	10 6 25,32
						Clock at mean NOon =		10 22 35,16
31	⊙'s 1st Limb	10 46 13, 0	46 40,50	47 5,80	47 32, 0	47 58,20		
	⊙'s 2d Limb	10 48 27,50	48 54,50	49 19,50	49 46, 0	50 12,80		
	⊙'s Centre	10 47 20,25	47 47,50	48 12,65	48 39, 0	49 5,50	10 48 12,92	10 5 40,13
						Clock at mean Noon =		10 21 52,67
Nov. 1	⊙'s 1st Limb	10 45 48,50	46 15,50	46 40,50	47 7, 0	47 33,50		
	⊙'s 2d Limb	10 48 2,50	48 29, 0	48 54,50	49 21, 0	49 47,50		
	⊙'s Centre	10 46 55,50	47 22,25	47 47,50	48 14, 0	48 40,50	10 47 47,87	10 4 56,07
						Clock at mean Noon =		10 21 10,51
P. M.	α Cygni -	4 55 53, 0	56 29,75	57 3,75	57 40,25	58 16, 0	4 57 4,42	4 14 7,71
	ξ ——	5 18 56,75	19 32,25	20 5,50	20 41, 0	21 16,25	5 20 6,21	4 37 9,14
	ζ ——	5 26 1,25	26 31, 0	26 59,25	27 29, 0	27 58,50	5 26 59,71	4 44 2,54
	e Pegasi -	5 34 34,50	35 1,75	35 27,50	35 55, 0	36 21,75	5 35 28, 0	4 52 30,71
	Ditto	——	——	35 27,50	35 55, 0	36 21,75	——	4 52 57,46
	ι ——	5 56 7,50	56 34,50	56 59,50	57 25,50	57 51,50	5 56 59,67	5 14 2,05
	t ——	6 19 17, 0	19 45,20	20 12, 0	20 40, 0	21 8,50	6 20 12,45	5 37 14,59
2	⊙'s 1st Limb	10 45 25,80	45 52,50	46 17,80	46 44,50	47 11, 0		
	⊙'s 2d Limb	10 47 40, 0	48 6,50	48 32, 0	48 58,50	49 25,20		
	⊙'s Centre	10 46 32,90	46 59,50	47 24,90	47 51,50	48 18,10	10 47 25,30	10 4 13,06
						Clock at mean Noon =		10 20 28,61
P. M.	μ Pegasi -	——	——	——	6 58 57,50	——	6 58 57,50	6 15 37,79
	——	——	——	6 58 29,50	58 57,50	——	6 58 43,50	6 15 23,79
	β ——	7 11 15, 0	11 44, 0	12 11,50	12 40,50	13 9, 0	7 12 11,92	6 28 52, 0

Comparisons of Clock with Chronometer 438 at Rio de Janeiro.

(2nd Series.)

Date.		Chronometer.	Clock.	Difference.
				Clock slow.
		h. m. s.	h. m. s.	h. m. s.
October 22, 1822,	P.M.	5 9 42,5	4 30 0	0 39 42,5
	——	6 45 44,0	6 6 0	0 39 44,0
	——	10 1 47,0	9 22 0	0 39 47,0
23,	Noon	10 9 57,0	9 30 0	0 39 57,0
	P.M.	5 1 2,5	4 21 0	0 40 2,5
	——	7 5 4·5	6 25 0	0 40 4,5
	——	8 33 6,0	7 53 0	0 40 6,0
24,	Noon	11 21 20	10 41 0	0 40 20,0
26,	Noon	11 4 0,5	10 23 0	0 41 0,5
28,	Noon	10 41 36,9	10 00 0	0 41 36,9
29,	Noon	10 55 55,5	10 14 0	0 41 55,5
30,	Noon	10 31 14,0	9 49 0	0 42 14,0
31	Noon	10 25 32,5	9 43 0	0 42 32,5
November 1,	Noon	10 25 51,5	9 43 0	0 42 51,5
	P.M.	5 48 57,5	5 6 0	0 42 57,5
	——	9 44 1,0	9 1 0	0 43 1,0
2,	Noon	11 6 12,5	10 23 0	0 43 12,5
	P.M.	4 20 17,0	3 37 0	0 43 17,0
	——	7 17 20,0	6 34 0	0 43 20,0

TABLE I.

Times by Clock at Transits of Stars,

Stars.	October 22nd.	23rd.	November 1st.	2nd.
	h. m. s.	h. m. s.	h. m. s.	h. m. s.
α Cygni	5 0 24, 0	4 55 47,04	4 14 7,71	——
ξ ——	5 23 25,60	——	4 37 9,14	——
ζ ——	5 30 19,10	5 25 41,31	4 44 2,54	——
e Pegasi . . .	5 38 46,91	——	4 52 30,71	——
e Pegasi, 3rd, 4th, and 5th wires	5 39 13,87	5 34 35,83	4 52 57,46	——
s —— . . .	6 0 18,13	5 55 40,76	5 14 2,05	——
t —— . . .	6 23 31,30	6 18 52,99	5 37 14,59	——
η ——	6 59 35,30	6 54 57,96	——	——
μ —— 4th wire . .	7 6 31,55	7 1 54,36	——	6 15 37,79
μ —— 4th and 5th wires .	——	7 1 40,36	——	6 15 23,79
β ——	——	7 15 7,99	——	6 28 52, 0

TABLE II.

Transits of Sun at Rio de Janeiro.

Time by Clock at mean Noon Oct. 23rd.	24th.	26th.	28th.	29th.	30th.	31st.	Nov. 1st.	2nd.
h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.	h. m. s.
10 27 26,78	10 26 44,94	10 25 21,88	10 23 58,88	10 23 16,68	10 22 35,16	10 21 52,67	10 21 10,51	10 20 28,61

TABLE III. (2nd Series.)

Rate of the Clock by the Stars—(*losing*.)					
Stars.	From 22d Oct. to 23d.	From 22d to 1 Nov.	22nd to 2nd	23d to 1st.	23rd to 2nd.
	s.	s.	s.	s.	s.
α Cygni . . .	41,05	41,72	—	41,79	—
ξ —— . . .	—	41,74	—	—	—
ζ —— . . .	41,88	41,75	—	41,73	—
e Pegasi . . .	—	41,71	—	—	—
e —— 3d 4th and 5th wires	42,13	—	—	41,69	—
ɪ —— . . .	41,46	41,70	—	41,72	—
t —— . . .	42,40	41,76	—	41,69	—
η —— 2d, 3d, 4th, and 5th wires . .	41,43	—	—	—	—
μ —— 4th wire	41,28	—	41,71	—	—
μ —— 3d and 4th wire .	—	—	—	—	41,75
β —— . . .	—	—	—	—	41,69
Mean of Rates .	41,66	41,73	41,71	41,72	41,72
Proportion of Rate for $3^m 56^s$	+ ,11	+ ,11	+ ,11	+ ,11	+ ,11
Rate of clock in a mean solar day	41,77	41,84	41,82	41,83	41,83
Time to which the above Rates are due . .	A. M. 23d	P.M. 27th	A. M. 28	A.M. 28th	P.M. 28th

TABLE IV.

Rate of the Clock by the Sun—(*losing*.)

From 23rd. to 24th.	23rd. to 26th.	23rd. to 28th.	23rd. to 29th.	23rd. to 30th.	23rd. to 31st.	23rd. to 1st.	23rd. to 2nd.	24th. to 26th.	24th. to 28th.	24th. to 29th.	24th. to 30th.
s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.
41,84	41,63	41,58	41,68	41,66	41,76	41,81	41,82	41,53	41,51	41,65	41,63

24th. to 31st.	24th. to 1st.	24th. to 2nd.	26th. to 28th.	26th. to 29th.	26th. to 30th.	26th. to 31st.	26th. to 1st.	26th. to 2nd.	28th. to 29th.	28th. to 30th.	28th. to 31st.
s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.
41,75	41,80	41,81	41,50	41,73	41,68	41,84	41,89	41,90	42,20	41,86	42,07

28th. to 1st.	28th. to 2nd.	29th. to 30th.	29th. to 31st	29th. to 1st.	29th. to 2nd.	30th. to 31st.	30th. to 1st.	30th. to 2nd.	31st. to 1st.	31st. to 2nd.	1st. to 2nd.
s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.	s.
42,09	42,05	41,52	42,00	42,06	42,02	42,49	42,32	42,18	42,16	42,03	41,90

Observations of Coincidences at Rio de Janeiro. (2nd Series.)

Temp. Fahrenheit.	Time of coincidence.	Arc of Vibration.	Mean Arc.	Interval in Seconds of Clock.	No. of Vibrations.	Observed Vibrations in 24 hours.	Correction for Arc.	Vibrations in 24 hours.
Clock losing 41s,82 at a mean rate. Oct. 23, A. M. Barom. 29,78.								
o	h. m. s.	o						
73	8 12 41	1,35	o					
	24 46	1,25	1,30	725			2,76	
	36 53	1,15	1,20	727			2,35	
	49 00	1,05	1,10	727			1,98	
	9 1 8	0,96	1,005	728			1,64	
	13 16	0,89	0,925	728			1,40	
	25 25	0,82	0,855	729			1,19	
	37 34	0,75	0,785	729			1,01	
74,3	49 44	0,71	0,730	730			0,87	
73,6				727,87	725,87	86120,89	1,65	86122,54
P. M. October 23. Barom. 29,71.								
76	1 16 47	1,34						
	28 50	1,23	1,285	723			2,70	
	40 53	1,14	1,185	723			2,29	
	52 57	1,05	1,095	724			1,96	
	2 5 3	0,95	1,000	726			1,63	
	17 10	0,88	0,915	727			1,37	
	29 16	0,82	0,850	726			1,18	
	41 24	0,76	,790	728			1,02	
76	53 32	0,70	,730	728			0,87	
76				725,62	723,62	86120,15	1,63	86121,78
A. M. October 24. Barom. 29,74.								
77	8 12 5	1,31						
	24 8	1,20	1,255	723			2,57	
	36 12	1,10	1,15	724			2,16	
78,1	48 16	1,02	1,06	724			1,84	
	9 0 22	0,95	0,985	726			1,58	
	12 27	0,87	0,91	725			1,35	
	24 34	0,81	0,84	727			1,15	
	36 40	0,75	0,78	726			0,99	
79	48 46	0,70	0,725	726			0,86	
78				725,12	723,12	86119,99	1,56	86121,55

Clock losing $41^s,82$ at a mean rate. Oct. 24, P.M. Barom. 29,73.

Temp. Fahrenheit.	Time of coincidence.	Arc of Vibration.	Mean Arc.	Interval in Seconds of Clock.	No. of Vibrations.	Observed Vibrations in 24 hours.	Correction for Arc.	Vibrations in 24 hours.
°	h. m. s.	°						
78,5	11 35 32	1,39	°					
	47 32	1,28	1,335	720			2,91	
	59 33	1,18	1,230	721			2,47	
	12 11 35	1,08	1,13	722			2,09	
	23 39	1,00	1,04	724			1,77	
78	35 43	0,92	0,96	724			1,51	
	47 47	0,85	0,885	724			1,28	
	59 52	0,79	0,820	725			1,10	
78	1 11 58	0,72	0,755	726			0,93	
78,2				723,25	721,25	86119,37	1,76	86121,13
Clock losing $41^s,82$.		October 25, A. M.			Barom. 29,88.			
76	8 20 00	1,34						
	32 2	1,23	1,285	722			2,70	
	44 6	1,13	1,180	724			2,28	
76,2	56 10	1,03	1,080	724			1,91	
	9 8 14	0,95	0,990	724			1,60	
	20 22	0,88	,915	728			1,37	
	32 28	0,81	,845	726			1,16	
	44 36	0,74	,775	728			0,98	
76,7	56 42	0,69	,715	726			0,83	
76,4				725,25	723,25	86120,03	1,60	86121,63
P. M. October 25.					Barom. 29,88.			
77	11 18 20	1,33						
	30 22	1,22	1,275	722			2,66	
	42 25	1,12	1 170	723			2,24	
76,4	54 28	1,02	1,020	723			1,70	
	12 6 34	0,94	0,98	726			1,57	
	18 40	0,88	0,91	726			1,35	
	30 46	0,82	0,85	726			1,18	
	42 52	0,76	0,79	726			1,02	
76,2	55 9	0,70	0,73	727			0,87	
76,5				724,87	722,87	86119,91	1,57	86121,48

Clock losing 41',82 at a mean rate. Oct. 26, A. M. Barom. 29,90.

Temp. Fahrenheit.	Time of coincidence.	Arc of Vibration.	Mean Arc.	Interval in Seconds of Clock.	No. of Vibrations.	Observed Vibrations in 24 hours.	Correction for Arc.	Vibrations in 24 hours.
°	h. m. s.	°						
76	8 42 20	1,43	°					
	54 21	1,32	1,375	721			3,09	
	9 6 23	1,21	1,265	722			2,61	
	8 28	1,11	1,160	725			2,20	
76,2	30 34	1,02	1,065	726			1,85	
	42 39	0,93	0,975	725			1,55	
	54 44	0,85	0,890	725			1,29	
	10 6 53	0,79	0,820	729			1,10	
76,5	19 2	0,74	0,765	729			0,95	
76,2				725,25	723,25	86120,03	1,83	86121,86
P. M. October 26.						Barom. 29,89.		
76	11 25 13	1,36						
	37 17	1,25	1,305	724			278	
	49 20	1,15	1,20	723			2,35	
	12 1 23	1,05	1,10	723			1,98	
76,5	13 29	0,96	1,005	726			1,65	
	25 36	0,89	0,925	727			1,40	
	37 43	0,82	0,855	727			1,19	
	49 50	0,77	0,795	727			1,03	
76,5	1 1 56	0,72	0,745	726			0,91	
76,3				725,37	723,37	86120,07	1,66	86121,73
October 27, A. M.						Barom. 29,90.		
73,9	8 6 57	1,34						
	19 3	1,23	1,285	726			2,70	
	31 9	1,13	1,180	726			2,28	
	43 16	1,03	1,080	727			1,91	
74,2	55 26	0,95	0,990	730			1,60	
	9 7 34	0,88	0,915	728			1,37	
	19 46	0,81	0,845	732			1,16	
	31 56	0,75	0,780	730			0,99	
74,5	44 8	0,70	0,725	732			0,86	
74,2				728,87	726,87	86121,21	1,66	86122,82

Clock losing $41^s,82$ at a mean rate. Oct. 27, P.M. Barom. 29,82.								
Temp. Fahrenheit.	Time of coincidence.	Arc of Vibration.	Mean Arc.	Interval in Seconds of Clock.	No. of Vibrations.	Observed Vibrations in 24 hours.	Correction for Arc.	Vibrations in 24 hours.
°	h. m. s.	°	°					
74,9	11 17 4	1,33						
	29 9	1,22	1,275	725			2,66	
	41 15	1,13	1,175	726			2,26	
	53 22	1,04	1,085	727			1,92	
74,9	12 5 28	0,95	0,975	726			1,55	
	17 36	0,88	,915	728			1,37	
	29 45	0,82	,850	729			1,18	
	41 56	0,75	,785	731			1,01	
74,8	54 5	0,70	,725	729			0,86	
74,9				727,62	725,62	86120,81	1,60	86122,41
October 28, A. M.						Barom. 29,79.		
74,5	8 13 15	1,36						
	25 20	1,25	1,305	725			2,78	
	37 26	1,15	1,200	726			2,35	
	49 32	1,06	1,105	726			1,99	
75,2	9 1 40	,98	1,020	728			1,70	
	13 48	,91	0,945	728			1,46	
	25 56	,84	0,875	728			1,25	
	38 8	,78	0,810	732			1,07	
75,5	50 16	,72	0,750	728			0,92	
75,1				727,62	725,62	86120,81	1,69	86122,50
P. M. October 28.						Barom. 29,76.		
75,9	11 13 48	1,36						
	25 53	1,25	1,305	725			2,78	
	37 59	1,15	1,200	726			2,35	
	50 5	1,05	1,100	726			1,98	
75,8	12 2 12	0,96	1,005	727			1,65	
	14 20	0,89	0,925	728			1,40	
	26 28	0,82	0,855	728			1,19	
	38 38	0,75	7 85	730			1,01	
75,5	50 48	0,69	,720	730			0,85	
75,7				727,50	725,50	86120,77	1,65	86122,42

Clock losing 41^s,82 at a mean rate. Oct. 29, A.M. Barom. 29,77.

Temp. Fahrenheit.	Time of coincidence.	Arc of Vibration.	Mean Arc.	Interval in Seconds of Clock.	No. of Vibrations.	Observed Vibrations in 24 hours.	Correction for Arc.	Vibrations in 24 hours.
°	h. m. s.	°						
74,7	7 47 45	1,33	°					
	59 52	1,22	1,275	727			2,66	
	8 11 58	1,12	1,170	726			2,44	
	24 6	1,03	1,075	728			1,89	
75	36 15	0,94	0,985	729			1,59	
	48 25	0,86	,900	730			1,32	
	9 00 34	0,79	,825	729			1,11	
	12 46	0,73	,760	732			0,94	
75,2	24 56	0,67	,700	730			,80	
75				728,87	726,87	86121,21	1,57	86122,78

P.M. October 29. Barom. 29,77.

Temp. Fahrenheit.	Time of coincidence.	Arc of Vibration.	Mean Arc.	Interval in Seconds of Clock.	No. of Vibrations.	Observed Vibrations in 24 hours.	Correction for Arc.	Vibrations in 24 hours.
75,1	11 19 12	1,33						
	31 17	1,22	1,275	725			2,66	
	43 24	1,12	1,170	727			2,24	
	55 31	1,03	1,075	727			1,89	
75,5	12 7 39	,94	0,985	728			1,59	
	19 48	,86	,900	729			1,32	
	31 58	,80	,830	730			1,12	
	44 8	,73	,765	730			0,95	
75,8	56 20	,68	,705	732			0,81	
75,5				728,50	726,50	86121,10	1,57	86122,67

October 30, A.M. Barom. 29,82.

Temp. Fahrenheit.	Time of coincidence.	Arc of Vibration.	Mean Arc.	Interval in Seconds of Clock.	No. of Vibrations.	Observed Vibrations in 24 hours.	Correction for Arc.	Vibrations in 24 hours.
75	8 16 36	1,39						
	28 41	1,28	1,335	725			2,91	
	40 47	1,18	1,230	726			2,47	
	52 54	1,09	1,135	727			2,10	
76	9 5 2	1,00	1,045	728			1,78	
	17 10	0,92	0,960	728			1,51	
	29 20	,84	,880	730			1,27	
	41 30	,78	,810	730			1,07	
76,8	53 40	,72	,750	730			0,92	
75,9				728,	726,	86120,87	1,75	86122,62

Clock losing 41s,82 at a mean rate. Oct. 30, P. M. Barom. 29,82.								
Temp. Fahrenheit.	Time of coincidence.	Arc of Vibration.	Mean Arc.	Interval in Seconds of clock.	No. of Vibrations.	Observed Vibrations in 24 hours.	Correction for Arc.	Vibrations in 24 hours.
°	h. m. s.	°						
76,5	1 16 56	1,38	°					
	28 59	1,27	1,325	723			2,87	
	41 3	1,17	1,220	724			2,43	
	53 10	1,07	1,120	727			2,05	
76,2	2 5 17	0,98	1,025	727			1,72	
	17 25	0,90	0, 94	727			1,44	
	29 33	,82	0, 86	728			1,21	
	41 42	,75	0,785	729			1,01	
76	53 54	,70	0,725	732			0,86	
76,2				727,25	725,25	86120,69	1,70	86122,39
October 31, A. M.						Barom. 29,89.		
76	8 7 1	1,35						
	19 5	1,24	1,295	724			2,74	
	31 11	1,14	1,190	726			2,31	
	43 17	1,05	1,095	726			1,96	
76,1	55 25	0,97	1,010	728			1,67	
	9 7 33	,89	0,930	728			1,41	
	19 42	,82	,855	729			1,19	
	31 52	,76	,790	730			1,02	
76,2	44 2	,70	,730	730			0,87	
76,1				727,62	725,62	86120,81	1,65	86122,46
P. M. October 31.						Barom 29,87.		
76,6	11 18 54	1,36						
	30 58	1,25	1,305	724			2,78	
	43 3	1,15	1,200	725			2,35	
	55 10	1,05	1,100	727			1,98	
76,5	12 7 18	0,97	1,010	728			1,67	
	19 26	,89	0,930	728			1,41	
	31 35	,82	,855	729			1,19	
	43 45	,76	,790	730			1,02	
76,5	55 55	,70	,730	730			0,87	
76,5				727,62	725,62	86120,81	1,66	86122,47

Clock losing $41^s,82$ at a mean rate. Nov. 1, A. M. Barom 29,82.

Temp. Fahrenheit.	Time of coincidence.	Arc of Vibration.	Mean Arc.	Interval in Seconds of Clock.	No. of Vibrations.	Observed Vibrations in 24 hours.	Correction for Arc.	Vibrations in 24 hours.
°	h. m. s.	°						
75,5	8 15 26	1,39	°					
	27 30	1,28	1,335	724			2,91	
	39 35	1 18	1,230	725			2,47	
	51 41	1,09	1,135	726			2,10	
76,4	9 3 47	1,00	1,045	726			1,78	
	15 54	0,92	0,960	727			1,51	
	28 3	,84	,880	729			1,27	
	40 12	,77	,805	729			1,06	
76,5	52 22	,72	,745	730			0,91	
76,1				727,	725,	86120,61	1,75	86122,36

P. M. November 1. Barom. 29,74.

Temp. Fahrenheit.	Time of coincidence.	Arc of Vibration.	Mean Arc.	Interval in Seconds of Clock.	No. of Vibrations.	Observed Vibrations in 24 hours.	Correction for Arc.	Vibrations in 24 hours.
77	11 52 47	1,41						
	12 4 49	1,30	1,355	722			3,00	
	16 52	1,20	1,250	723			2,55	
	28 56	1,11	1,145	724			2,14	
77,2	41 2	1,02	1,065	726			1,85	
	53 9	0,93	0,975	727			1,55	
	1 5 14	,86	,895	725			1,31	
	17 21	,80	,830	727			1,12	
77,2	29 28	,75	,775	727			0,98	
77,1				725,12	723,12	86119,99	1,81	86121,80

November 2, A. M. Barom. 29,71.

Temp. Fahrenheit.	Time of coincidence.	Arc of Vibration.	Mean Arc.	Interval in Seconds of Clock.	No. of Vibrations.	Observed Vibrations in 24 hours.	Correction for Arc.	Vibrations in 24 hours.
77,8	8 8 42	1,34						
	20 45	1,23	1,285	723			2,70	
	32 49	1,13	1,180	724			2,28	
	44 52	1,03	1,080	723			1,91	
78,8	56 57	0,94	0,985	725			1,59	
	9 9 2	,87	,905	725			1,34	
	21 8	,81	,840	726			1,15	
	33 14	,75	,780	726			0,99	
78,9	45 22	,70	,725	728			,86	
78,5				725,	723,	86119,95	1,60	86121,55

Clock losing 41s,82 at a mean rate. Nov. 2, P. M. Barom. 29,69.								
Temp. Fahrenheit.	Time of coincidence.	Arc of Vibration.	Mean Arc.	Interval in Seconds of Clock.	No. of Vibrations.	Observed Vibrations in 24 hours.	Correction for Arc.	Vibrations in 24 hours.
°	h. m. s.							
78,5	11 2 55	1,39						
	14 55	1,28	1,335	720			2,91	
	26 57	1,18	1,230	722			2,47	
	39 1	1,09	1,135	724			2,10	
79,	51 5	1,00	1,045	724			1,78	
	12 3 10	0,92	0,960	725			1,51	
	15 15	,85	,885	725			1,28	
	27 20	,78	,815	725			1,08	
79,9	39 25	,72	,750	725			0,92	
79,1				723,75	721,75	86119,54	1,76	86121,30

TABLE V. *(2nd Series.)*

Vibrations of the Pendulum at Rio de Janeiro,
the Clock making 86358,18 Vibrations in a mean Solar Day.

Date.	Barometer.	Thermometer.	Difference of Temperature and 68°	Vibrations of Pendulum in 24 hours, corrected for Arc.	Correction for Temperature.	Vibrations in 24 hours at Temperature 68 degrees.
October	Inches.	°				
23 A. M.	29,78	73 6	5,6	86122,54	+ 2,37	86124,91
P. M.	29,71	76 0	8,0	86121,78	+ 3,38	86125,16
24 A. M.	29,74	78 0	10,0	86121,55	+ 4,23	86125,78
P. M.	29,73	78,2	10,2	86121,13	+ 4,31	86125,44
25 A. M.	29,88	76,4	8,4	86121,63	+ 3,55	86125,18
P. M.	29,88	76,5	8,5	86121,48	+ 3,59	86125,07
26 A. M.	29,90	76,2	8,2	86121,86	+ 3,47	86125,33
P. M.	29,89	76,3	8,3	86121,73	+ 3,51	86125,24
27 A. M.	29,90	74,2	6,2	86122,82	+ 2,62	86125,44
P. M.	29,82	74,9	6,9	86122,41	+ 2,92	86125,33
28 A. M.	29,79	75,1	7,1	86122,50	+ 3,00	86125,50
P. M.	29,76	75,7	7,7	86122,42	+ 3,26	86125,68
29 A. M.	29,77	75,0	7,0	86122,78	+ 2,96	86125,74
P. M.	29,77	75,5	7,5	86122,67	+ 3,17	86125,84
30 A. M.	29,82	75,9	7,9	86122,62	+ 3,34	86125,96
P. M.	29,82	76,2	8,2	86122,39	+ 3,47	86125,86
31 A. M.	29,89	76,1	8,1	86122,46	+ 3,43	86125,89
P. M.	29,87	76,5	8,5	86122,47	+ 3,59	86126,06
Nov. 1 A. M.	29,82	76,1	8,1	86122,36	+ 3,43	86125,79
P. M.	29,74	77,1	9,1	86121,80	+ 3,85	86125,65
A. M.	29,71	78,5	10,5	86121,55	+ 4,44	86125,99
P. M.	29,69	79,1	11,1	86121,30	+ 469	86125,99
Mean	29,80	76,2			Mean	86125,53

TABLE VI. (*2nd Series.*)

By the Stars.

	Correct Vibrations in a mean solar day.	No. of Stars observed.	Interval of Transits.	Sum of Factors.
Oct. 23 A.M. to 23rd P.M.	86125,08	7	1	7
Nov. 1st P.M.	86125,52	6	10	60
— 2d P.M.	86125,58	1	11	11
24 A.M. to 1st P.M.	86125,59	5	10	50
2d P.M.	86125,63	2	10	20
	86125,48			148

TABLE VII. (2*nd. Series.*)

By the Sun.

	Correct Vibrations in a mean solar day.	No. of Stars observed.	Interval of Transits.	Sum of Factors.
From Oct. 23d P.M. to 24th A.M.	86125,45	2	1	2
— 26th A.M.	86125,52	2	3	6
— 28th A.M.	86125,59	2	5	10
— 29th A.M.	86125,55	2	6	12
— 30th A.M.	86125,64	2	7	14
— 31st A.M.	86125,59	2	8	16
— Nov. 1st A.M.	86125,58	2	9	18
— 2d A.M.	86125,60	2	10	20
From — 24th P.M. to 26th A.M.	86125,54	2	2	4
— 28th A.M.	86125,63	2	4	8
— 29th A.M.	86125,56	2	5	10
— 30th A.M.	86125,67	2	6	12
— 31st A.M.	86125,60	2	7	14
— Nov. 1st A.M.	86125,60	2	8	16
— 2d	86125,62	2	9	18
From — 26th P.M. to 28th A.M.	86125,70	2	2	4
— 29th A.M.	86125,58	2	3	6
— 30th A.M.	86125,73	2	4	8
— 31st A.M.	86125,63	2	5	10
— Nov. 1st A.M.	86125,62	2	6	12
2d A.M.	86125,63	2	7	14
From — 28th P.M. to 29th A.M.	86125,33	2	1	2
— 30th A.M.	86125,76	2	2	4
— 31st A.M.	86125,58	2	3	6
— Nov. 1st A.M.	86125,58	2	4	8
— 2d A.M.	86125,62	2	5	10
From — 29th P.M. to 30th A.M.	86126,20	2	1	2
— 31st A.M.	86125,71	2	2	4
— Nov. 1st A.M.	86125,66	2	3	6
— 2d A, M.	86125,68	2	4	8
From — 30th P.M. to 31st A.M.	86125,20	2	1	2
— Nov. 1st A.M.	86125,37	2	2	4
— 2d A.M.	86125,50	2	3	6
From — 31st P.M. to Nov. 1st A.M.	86125,58	2	1	2
— 2d A.M.	86125,66	2	2	4
From Nov. 1 P.M. to Nov. 2d A.M.	86125,74	2	1	2
Mean	86125,61			304

Thus we have obtained 86125,61 vibrations made by the pendulum by the transits of the sun, and by the stars 86125,48.

But the sum of the factors for the sun being 304, and that for the stars only 148, we have 0,04 to subtract from the vibrations given by the sun to arrive at 86125,57, the mean number of vibrations made by the pendulum in 24 hours.

The ball of the pendulum was elevated above the level of the sea 72 feet, the correction for which is ,293; but from the nature of the ground on which the pendulum stood, this requires to be multiplied by $\frac{6}{10}$ to obtain the true correction due to this elevation, or +0,18.

The correction for the buoyancy of the atmosphere is +5,80, to which must be added 0,18, and we obtain 5,98 for the final correction to be added to 86125,57, the mean number of vibrations made in 24 hours; and thus we arrive at 86131,55, for the number of vibrations that would be made by the pendulum in vacuo at the level of the sea and temperature 68° at Rio de Janeiro in latitude 22° 55′ 22″ south, and longitude $43\frac{1}{4}$° west from Greenwich.

From the above data, with the number of this pendulum's vibrations determined in London on the return,* and the length of the seconds' pendulum there, the length of the pendulum vibrating seconds at Rio de Janeiro appears to be 39,04368 inches; and comparing this with the lengths ascertained at different places by Captain KATER, we obtain the following ellipticities.

Stations compared with Rio de Janeiro in Lat. 22° 55′ 22″ S.				Diminution of Gravity from Pole to Equator	Ellipticity.	Length of Equatorial Pendulum.
Unst . in Lat.	60°	45′	28″ N.	,0053726	$\frac{1}{305,07}$	39,01188
Portsoy . .	57	40	59	,0053732	$\frac{1}{305,13}$	,01188
Leith Fort .	55	58	41	,0053570	$\frac{1}{303,63}$	,01198
Clifton . .	53	27	43	,0053109	$\frac{1}{299,44}$	,01225
Arbury Hill .	52	12	55	,0053565	$\frac{1}{303,59}$	,01198
London . .	51	31	8	,0053151	$\frac{1}{299,81}$	,01223
Shanklin Farm	50	37	24	,0053163	$\frac{1}{299,92}$	,01222
				=,0053431	$\frac{1}{302,37}$	39,01206

* See Remarks after the Experiment, in the Appendix.

Observations for the Latitude.

October 16, 1822. *By Stars.* Barometer 29,75. Thermometer 74°.

α Aquilæ.
Face of Instrument East.

	°	′	″
Readings 1st Vernier -	31	18	25
Readings 2d Vernier -		19	10
Observed merid. zen. dist. of α Aquilæ - -	31	18	47,5
Refraction -	+		33,5
✱'s true merid. zenith dist.	31	19	21,0
✱'s Declination - -	8	24	35,9 N
Latitude, face East -	22	54	45,1 S
Latitude, face West -	22	56	3,7
Latitude of Gloria Hill, Rio Janeiro - -	22	55	24,4 S

α Cygni.
Face of Instrument West.

	°	′	″
Readings 1st Vernier -	22	27	5
Readings 2d Vernier -		26	25
Observed meridian altitude of α Cygni - -	22	26	45
Refraction -	—	2	11,4
True altitude of α Cygni	22	24	33,6
True meridian zenith dist.	67	35	26,4
Declination of α Cygni -	44	39	22,7 N
Latitude, face West -	22	56	3,7 S

By the Sun.

November 3, 1822.
Barometer 29,76. Thermometer 92°.
Face of Instrument West.

	°	′	″
Readings 1st Vernier -	81	50	10
Readings 2d Vernier -		49	35
		99	45
⊙'s observed altitude, L. L.	81	49	52,5
⊙'s semi-diameter -	+	16	9,9
Apparent altitude ⊙'s centre	82	6	2,4
Refraction -	—		7,4
Parallax -	+		1,6
True altitude ⊙'s centre -	82	5	56,6
⊙'s meridian zenith distance	7	54	3,4
⊙'s Declination - -	15	1	55,8 S
South latitude, face West	22	55	59,2

November 8, 1822.
Barometer 29,82. Thermometer 85°.
Face of Instrument East.

	°	′	″
Readings 1st Vernier -	6	37	40
Readings 2d Vernier -		38	12
		75	52
Observed meridian zenith distance ⊙'s L. L. -	6	37	56
⊙'s semi-diameter -	—	16	11
Apparent meridian zenith distance ⊙'s centre -	6	21	45
Refraction -	+		6,0
Parallax -	—		1,5
Mer. zen. dist. ⊙'s centre true	6	21	49,5
⊙'s Declination - -	16	32	50,4 S
South latitude, face East	22	54	39,9
Ditto face West	22	55	59,2
Latitude by the Sun -	22	55	19,5 S

	°	′	″
Latitude by Stars -	22	55	24,4
Latitude by the Sun -	22	55	19,5
Mean latitude of Gloria Hill, Rio de Janeiro	22	55	22 South.

APPENDIX.

Second Series of Experiments at London, on the return from South America.

17th Aug. 1823, P.M. at Mr. Browne's. Clock gaining $0^s,90$. Barom. 29,86.

Temp. Fahrenheit.	Time of coincidence.	Arc of Vibration.	Mean Arc.	Interval in Seconds.	No. of Vibrations.	Observed Vibrations in 24 hours.	Correction for Arc.	Vibrations in 24 hours.
°	h. m. s.	°						
66,2	12 18 33	1,17	°					
66,0	35 20	1,07	1,12	1007		86229,30	2,05	86231,35
	52 10	0,97	1,02	1010		29,81	1,70	31,51
	1 9 00	0,88	0,93	1010		29,81	1,41	31,22
	25 53	0,79	0,83	1013		30,32	1,12	31,44
66,9	42 47	0,72	0,76	1014		30,69	0,94	31,63
66,6	59 40	0,67	0,70	1013		30,32	0,80	31,12
66,4	Mean			1011,17	1009,17	86230,04	1,34	86231,38

18th. Aug. P. M. Clock gaining $0^s,90$. Barom. 29,88.

Temp. Fahrenheit.	Time of coincidence.	Arc of Vibration.	Mean Arc.	Interval in Seconds.	No. of Vibrations.	Observed Vibrations in 24 hours.	Correction for Arc.	Vibrations in 24 hours.
67,2	12 13 25	1,15						
67,1	30 11	1,05	1,10	1006		86229,13	1,98	86231,11
	46 58	0,96	1,00	1007		29,30	1,64	30,94
	1 3 49	0,87	0,91	1011		29,98	1,35	31,33
	20 41	0,79	0,83	1012		30,15	1,12	31,27
67,1	37 34	0,72	0,76	1013		30,32	0,94	31,26
67,0	54 29	0,66	0,69	1015		30,66	0,78	31,44
67,1	Mean			1010,67	1008,67	86229,92	1,30	86231,22

19th Aug. P. M. Clock gaining $0^s,60$. Barom. 29,80.

Temp. Fahrenheit.	Time of coincidence.	Arc of Vibration.	Mean Arc.	Interval in Seconds.	No. of Vibrations.	Observed Vibrations in 24 hours.	Correction for Arc.	Vibrations in 24 hours.
67,7	2 28 12	1,19						
67,9	44 59	1,08	1,13	1007		86229,00	2,09	86231,09
	3 1 47	0,98	1,03	1008		29,17	1,74	30,91
	18 37	0,90	0,94	1010		29,51	1,45	30,96
	35 31	0,82	0,86	1014		30,19	1,21	31,40
68,9	52 25	0,74	0,78	1014		30,19	0,99	31,18
68,5	4 19 17	0,69	0,71	1012		29,85	0,82	30,67
68,3	Mean			1010,83	1008,83	86229,65	1,38	86231,03

20th Aug P. M. at Mr. BROWNE'S. Clock gaining 0^s,60. Barom. 29,83.

Temp. Fahrenheit.	Time of coincidence.	Arc of Vibration.	Mean Arc.	Interval in Seconds.	No. of Vibrations.	Observed Vibrations in 24 hours.	Correction for Arc.	Vibrations in 24 hours.
o	h. m. s.	o						
67,4	12 1 39	1,13	o					
67,1	18 27	1,03	1,08	1008		86229,17	1,91	86231,08
	35 18	0,94	0,98	1011		29,68	1,57	31,25
	52 12	0,84	0,88	1014		30,19	1,27	31,46
	1 9 7	0,77	0,80	1015		30,36	1,05	31,41
67,9	26 1	0,71	0,74	1014		30,19	0,89	31,08
67,7	42 56	0,65	0,68	1015		30,36	0,76	31,12
67,5	Mean			1012,83	1010,83	86229,99	1,24	86231,23

21st. Aug. P. M. Clock gaining 1^s,00. Barom. 29,84.

Temp. Fahrenheit.	Time of coincidence.	Arc of Vibration.	Mean Arc.	Interval in Seconds.	No. of Vibrations.	Observed Vibrations in 24 hours.	Correction for Arc.	Vibrations in 24 hours.
66,2	11 30 31	1,25						
66,0	47 17	1,13	1,19	1006		86229,23	2,32	86231,55
	12 4 5	1,02	1,08	1008		29,57	1,91	31,48
66,3	20 54	0,93	0,97	1009		29,74	1,54	31,28
65,9	37 45	0,83	0,88	1011		30,08	1,27	31,35
66,3	54 39	0,75	0,79	1014		30,59	1,02	31,61
66,0	1 11 33	0,69	0,72	1014		30,59	0,85	31,44
66,1	Mean			1010,33	1008,33	86229,97	1,48	86231,45

21st Aug. P. M. Clock gaining 1^s,00. Observed by Captain KATER. Barom. 29,85.

Temp. Fahrenheit.	Time of coincidence.	Arc of Vibration.	Mean Arc.	Interval in Seconds.	No. of Vibrations.	Observed Vibrations in 24 hours.	Correction for Arc.	Vibrations in 24 hours.
66,4	2 59 5	1,29						
66,1	3 15 49	1,16	1,22	1004		86228,89	2,43	86231,32
	32 36	1,05	1,10	1007		29,40	1,98	31,38
	49 25	0,95	1,00	1009		29,74	1,64	31,38
	11 16	0,85	0,90	1011		30,08	1,32	31,40
66,7	23 7	0,76	0,80	1011		30,08	1,05	31,13
66,4	40 0	0,71	0,73	1013		30,42	0,87	31,29
66,4	Mean			1009,17	1007,17	86229,77	1,55	86231,32

22d Aug. P.M. at Mr. Browne's. Clock gaining $0^s,80$. Bar. 29,72.

Temp. Fahrenheit.	Time of coincidence.	Arc of Vibration.	Mean Arc.	Interval in Seconds.	No. of Vibrations.	Observed Vibrations in 24 hours.	Correction for Arc.	Vibrations in 24 hours.
°	h, m. s.	°						
66,5	11 47 7	1,20	°					
66,2	12 3 53	1,09	1,14	1006		86229,03	2,13	86231,16
	20 42	0,99	1,04	1009		29,54	1,77	31,31
66,5	37 32	0,88	0,94	1010		29,71	1,44	31,15
66,3	54 24	0,80	0,84	1012		30,05	1,15	31,20
66,7	1 11 19	0,73	0,76	1015		30,56	0,94	31,50
66,4	28 14	0,67	0,70	1015		30,56	0,80	31,36
66,4	Mean			1011,17	1009,17	86229,91	1,37	86231,28

RESULTS.

Date.		Barometer.	Thermom.	Vibrations in 24 hours.	Correction for Temp.	Vibrations in 24 hours at Temp. 68 degrees.
		Inches.	°			
August	17	29,86	66,4	86231,38	— 0,68	86230,70
——	18	29,88	67,1	86231,22	— 0,38	86230,84
——	19	29,80	68,3	86231,03	+ 0,11	86231,14
——	20	29,83	67,5	86231,23	— 0,21	86231,02
——	21	29,84	66,1	86231,45	— 0,80	86230,65
Observed by Capt. Kater	21	29,85	66,4	86231,32	— 0,68	86230,64
——	22	29,72	66,4	86231,28	— 0,66	86230,62
Mean		29,83	66,9			86230,80
Correction for Buoyancy . .						+ 5,93
Ditto for Elevation						+ ,22
No. of vibrations of the pendulum in London in Aug. 1823						86236,95
Ditto in May 1820, before the experiments in South America were made						86235,98
Difference between the Experiments of 1820 and 1823 .						0,97

REMARKS.

As it was not possible that so great a difference could arise from errors of observation, it became an object of anxious inquiry to discover the cause. Captain Kater was disposed to assign it to an accident which had happened to the pendulum at San Blas, but which I, at first, imagined inadequate to such an effect. The accident was this: the pendulum, when not in use, was, as usual,

raised by means of a screw, so that the knife edge was lifted clear of the agate planes on which it vibrated during the experiments. This screw being too small, or having some flaw in it, unexpectedly broke at San Blas before the experiments there were begun; and although the knife edge was not raised more than the twentieth of an inch, yet, as the pendulum weighed more than 15 lbs., the fall might, he thought, have altered the form of so delicate an edge in a slight degree, and thus have virtually lessened the distance between the point of suspension and the centre of oscillation.*

As the whole pendulum had acquired a coating of oxide, with the exception of the tail piece, which was lackered, I was desirous of ascertaining in what manner and to what degree its vibrations would be affected by this partial addition of weight; and for this purpose the following experiments were made. The vibrations of the pendulum in its oxydized state having been determined, 10 grains of weight were affixed at $\frac{2}{3}$ of the length of the bar (measured through the ball), from the point of support, that being supposed to be near the centre of oscillation of the oxide. This had for its object to discover, before cleaning the pendulum, what would be the effect of an addition of weight at that place. On swinging it accordingly, the number of vibrations was increased 0,83 in 24 hours. It was then taken to the Mint, and the weight, carefully determined by Mr. BARTON in one of his delicate balances, was found to be 15 lb. 10 oz. 14 dwt. $12\frac{1}{2}$grs. It was next cleaned by Captain KATER, by means of diluted sulphuric acid, and afterwards washed with a solution of soda in water, and being effectually dried, was again weighed, when it was found to have lost exactly $24\frac{3}{4}$ grains. Coincidences were now taken on three succeeding days, and the number of vibrations of the pendulum in its clean state proved to be fewer than when it was coated with oxide by only 0,73 of a vibration. Since no more than $\frac{1}{5}$ part of the oxide removed could be oxygen, only $\frac{1}{5}$ of the above difference between its vibrations when clean and when coated, or 0,14, can be ascribed to additional weight since it was formerly swung in 1820; the real difference, however, to be accounted for being 0,97, this cause is manifestly inadequate to the effect. I have therefore thought it right, after attentively considering every other possible manner in which the pendulum could have been altered, to adopt the idea which had been suggested, and which was eventually proved to be correct, since the knife edge, upon removal after the experiments were over, was found to be distinctly rounded. To obtain the most correct results, I have accordingly used the vibrations made in London in 1820, to compare with the experiments made before the accident, and the vibrations recently determined in London for comparing with those made after it; an arrangement rendering the resulting ellipticities entirely independent of that circumstance.

* If the knife edge be supposed to have become cylindrical, the virtual point of suspension, it has been demonstrated, would be at the distance of the radius of curvature of this cylindrical portion below its surface, and the number of vibrations of course be greater than before.